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Concrete Control*

Methods Employed in the Construction of a Six Million Gallon Filtered Water Reservoir

By W. C. Mabee†

A six-million gallon filtered water reservoir was constructed in 1926 by the Indianapolis Water Company at their Fall Creek Station. This reservoir occupies a space approximately 270 feet square, with a gross area of more than 60,000 square feet. It has an overall depth of 16 feet. The roof is a flat slab, 8 inches thick, supported by circular columns 20 inches in diameter, spaced 16 feet on centers and resting on a groined arch floor having a minimum thickness of 8 inches.

Local ground water conditions made necessary the provision that the structure and loading should have weight sufficient to balance an upward pressure of ground water with the reservoir nearly empty, hence the groined arch floor design. Incidentally, the arched floor forms valleys which permit easy cleaning.

The reservoir contains over 5,000 cubic yards of concrete of two grades. The floor and wall concrete was made with a water cement ratio by volume of .8, or 6 gallons of water per cubic foot of cement, and the flat slab .83 or 6¼ gallons, as nearly as it could be determined within practical limits, aiming at a 28-day strength test of not less than 2,500 pounds per square inch in compression, and a watertight concrete throughout.

Two 6-inch diameter cylinders, each 12 inches long were made each day from the same batch, taken after it was deposited in the forms and tested as follows:

Grouping these results and comparing them with Abram's curve, the 6-gallon mix yielded an average

6 gal. Mix. $\frac{W}{C} = .8$

No. of Tests	7-day Average lbs. sq. in.	No. of Tests	28-day Average lbs. sq. in.
31	2,180	24	3,520
Maximum	3,240	..	4,690
Minimum	1,480	..	2,430

6¼ gal. Mix. $\frac{W}{C} = .83$

No. of Tests	7-day Average lbs. sq. in.	No. of Tests	28-day Average lbs. sq. in.
10	1,830	10	3,200
....	2,510	..	4,350
....	910	..	2,250

*Paper before the Indiana Section of the American Waterworks Association.

†Acting Chief Engineer, Indianapolis Water Company.

PART OF RESERVOIR, SHOWING BOTTOM AND SIDE WALL REINFORCEMENT

strength at 28 days of 3,570 pounds per square inch for 45 samples broken, after allowing for increase in 28-day strength over 7-day strength, corresponding to 3,000 on Abram's curve "A." The 6¼-gallon mix indicated a somewhat similar result. These results were gratifying and were made possible by the following: Care in the selection of aggregates, and in the combination of sand and gravel; selection of the water-cement ratio and the design of the mix that would make a workable concrete; reasonably careful measurements of aggregates as delivered to the mixer; actual measurement of the water added to each batch after making an allowance for moisture in the sand and gravel; control of the time of mixing by the use of a time lock in the mixer; distribution of the concrete without segregation of the materials; agitation or puddling in forms, particularly in narrow walls or columns; and, curing the concrete in wet or moist condition.

These are the important steps in the field control of concrete, which promote better uniformity in concrete construction.

The letting of a contract in Indianapolis for concrete proportioned by the water-cement ratio, was, so far as the writer has knowledge, the second instance of this kind. In order, therefore, to eliminate the uncertainty of the contractor as to the amount of cement that would be required, and to enable all bids to be made on a comparable basis, the company fixed the quantity at 1½ barrels per cubic yard of concrete, with a provision in the contract for compensation if more than this amount were used and a saving to the company if less cement were used.

The quantity actually used amounted to 1.535 barrels per cubic yard or 2⅓% in excess of the amount estimated. This included cement used in top finish dusting, where a trowelled surface was specified. This provision in the contract removed the incentive to skimp the work on the part of the contractor and was a satisfactory arrangement for the company.

The specification provided that the strength of test specimens at 28 days should be 2500 pounds per square inch. Twenty-four cylinders tested at 28 days taken from concrete mixed with a water-cement ratio of .80 developed the following strength:

Less than 2500 lbs. per sq. in.	1	cylinder
2500 to 3000 " " " "	7	"
3000 to 3500 " " " "	5	"
3500 to 4000 " " " "	5	"
4000 to 4500 " " " "	5	"
Over 4500 " " " "	1	"

Average 3520 for the 24 cylinders

The average of 3570 was arrived at by combining the probable strength at 28 days of those specimens tested at 7 days with the 28 day test.

The first step in the design of the field mix after assuming the water-cement ratio of .80 or 6 gallons of water to the sack of cement was to determine the ratio of fine to coarse aggregates. This was done in the manner prescribed by the Portland Cement Association Manual and involved screening, drying and weighing.

The sand and gravel obtained locally was washed and screened and proved satisfactory in every way. It was combined with a fineness modulus of 5.6.

While the field mix was calculated approximately 1:1.9:3.5 it is probable that the actual mix was nearer 1:1.7:3.4 as reflected in the quantities of aggregate actually purchased. The sand and gravel were stored in separate bins and discharged into a measuring hopper divided into two sections, which were marked off by trial to hold their respective quantities.

Numerous test for moisture in the sand yielded results ranging from 3.7%, by weight, measured loose to 12½%, with an average of 7%. The coarse aggregate indicated about 3%.

Six gallons of water to the sack of cement was the maximum water allowed. Because of the wide variation of moisture in the sand, the quantity of water added to each batch was usually determined from the higher percentages found, so that in all probability the water-cement ratio was somewhat less than .80. A tank calibrated to a scale graduated to gallons was used to measure the additional make-up water and care was exercised in filling this tank to the required level.

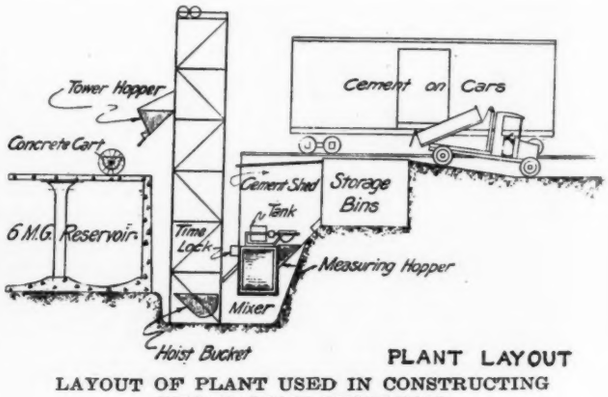
If it was found necessary to increase the workability of the concrete, this was done by reducing the quantity of aggregates, usually the coarse aggregate, and allowing the water-cement ratio to remain constant. Four sacks of cement were used in a batch and from 16 to 18 gallons of water added. Each batch contained two-thirds of a cubic yard of concrete.

Increasing the time of mixing produces a somewhat stronger, more workable, more homogenous and, consequently, a more nearly water-tight concrete.

The time of mixing was one and one-half minutes which is a half minute longer than the usual allowance and was accomplished by means of a time-lock on the mixer. The discharging lever could not be operated until a gong sounded announcing that the time interval had elapsed. The 1½ minutes is measured after all materials are in the mixer and until the batch is discharged.

A short tower and hoist was used to raise the concrete from the mixer in a pit to an elevation that would permit it to fall into a hopper from which it was discharged into concrete carts and wheeled to position without segration.

At least two slump tests were made daily and varied from 1 inch to 8 inches, usually about 3 inches, in the floor concrete and about 6 inches in the flat slab and 7 inches in walls; they were made in the regular way. The slump test is a useful index to workability and indicates whether the concrete is



LAYOUT OF PLANT USED IN CONSTRUCTING INDIANAPOLIS RESERVOIR

too stiff or too wet. Visual observation of uniformity is not sufficiently reliable, however experienced the observer may be.

Reservoir concrete is intended to prevent the percolation of water and it was essential that the mass be puddled quite thoroughly to prevent honeycombing and to present a smooth surface upon the removal of forms. The floor was dusted with a mixture of sand and cement and trowelled smooth while the concrete was still plastic. Absolutely tight forms are not essential as excess water that escapes through forms reduces water-cement ratio and increases strength.

It has been found by experiment that concrete moist-cured will develop from one and one-half to three times the 28-day strength of dry cured concrete. Concrete is kept wet, not to permit moisture to enter, but to prevent the moisture that is already there from escaping until the chemical reactions have been completed. The floor was covered with burlap and kept wet for 7 days. The roof was floated by means of mortar dams built about the margins of each day's work and an effort made to keep it flooded for a week. No practical way was found for keeping the walls moist except that the forms were allowed to remain for a longer period than would otherwise have been necessary.

Local conditions were in favor of a simple plant layout as illustrated in the sketch. Cement was brought in on the station coal trestle, chuted down into the cement house and wheeled a very short distance to the mixer.

By placing the mixer in a pit just outside the structure it was possible to chute sand and gravel from the unloading bins directly into the measuring hopper, over the mixer. Concrete carts were used for transporting concrete.

Ten weeks were required to complete the work, the average rate of placing being 500 cubic yards per week, elapsed time. After the first two weeks the contractor struck his stride and the rate of a progress from then on was fairly uniform.

A resident engineer was placed in charge of this work and he was given an assistant engineer; both acted as inspectors, gave lines and grades, made test cylinders, slump tests, sieve analyses, moisture determinations and reported daily progress and quantities involved.

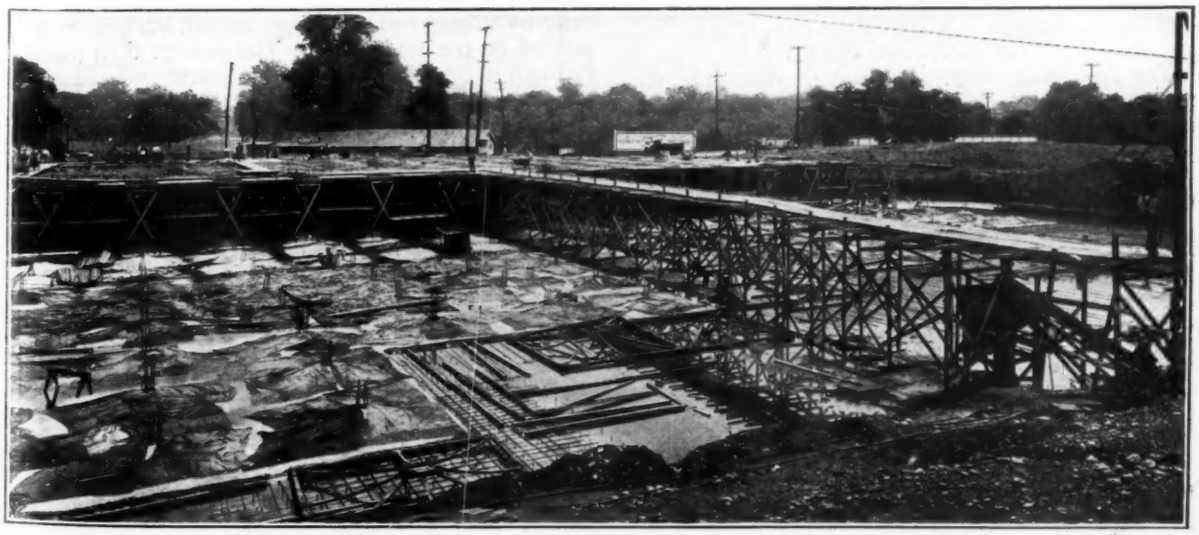
A leakage test, extending over a period of 24 hours made several weeks after the completion of the work, indicated a loss of 21,000 gallons or about 0.3%, excluding evaporation. The depth of water at test was 14 feet.

In structures designed to withstand exposure to water and weather, the strength factor is secondary to density; concrete that will flow in chutes is too wet for this character of work unless the aggregate is reduced while maintaining the same water-cement ratio. Good materials, otherwise suitable, may be spoiled by too much water. Durability can only be obtained by subordinating strength and economy. A concrete amply strong for the required loadings may be of such a porus nature that it will not withstand the elements and will in a few years show signs of disintergration.

Porosity occurs when very wet mixtures are used causing segregation of the materials in handling. Disintegration sets in when moisture enters and is assisted by freezing with its consequent expansion and disruption. This usually begins at the water line but may occur at day joints improperly made, permitting water to percolate through the structure, giving opportunity for saturation and subsequent freezing.

The requirements for durable concrete are clean aggregates, a fairly rich mixture, placing without segregation, and proper curing.

In the general run of building operations in Indianapolis the sand is brought to the site of the work where there is small storage space, consequently there is slight opportunity for the moisture to escape and in the absence of scientific water control, a good practice is to deduct one gallon of water from the quantity required under the assumed



GENERAL VIEW OF RESERVOIR, SHOWING SUPPORT FOR ROOF SLAB FORMS. GROINED ARCH BOTTOM COVERED FOR CURING. BOTTOM FORMS AT CENTER FRONT.

water-cement ratio for each cubic foot of sand that goes into the batch. This allowance compensates for about 9% of moisture in the aggregates.

Acknowledgement is made for the co-operation and assistance of Carl Geupel, the local representative of the Thompson-Binger Co., contractors; to B. J. T. Jeup, Chief Engineer of the Indianapolis Water Company, and to the local representatives of the Portland Cement Association.

Railways Adopt Water-Cement Ratio

The American Railway Engineering Association on March 10 officially adopted a specification for proportioning concrete based on the water-cement ratio of strength. The adoption of this specification makes it the recommended standard practice for all railroads in United States and Canada.

This means the abandonment of arbitrary mixtures of cement and aggregate for one in which the ratio of water to cement is specified and the proportion of sand and stone is largely left to the discretion of the individual engineer. According to this law, the strength of concrete within the limits of plastic, workable mixes, is inversely proportional to the amount of water used.

The association also accepted the new specification for Portland cement which was recently adopted by the American Society for Testing Materials, having been prepared by Committee C 1 of that society.

Separate Sludge Digestion in Wisconsin

Description of plants at Hartford and Antigo. Mechanical agitators. Gases from digesting sludge used to heat the sludge during cold weather. Cost less than two-story tanks.

By Jerry Donohue*

The first municipal sewage treatment plant built in Wisconsin was constructed in Madison in 1890. By 1926, 55 per cent. of the urban population of Wisconsin were tributary to some type of disposal plant. The type usually adopted at first by cities was the settling tank or septic tank, many of which gave trouble in operation because of neglect and lack of proper responsibility in operation. During the past decade the two-story Imhoff tank has been generally accepted as best fulfilling the demands of a sewage plant for most cities and villages. Thirty-three Wisconsin municipalities have Imhoff tanks in operation and thirty-seven have the old type septic tank. Seven cities have semi-aeration tanks, one activated sludge and six have separate sludge digestion.

THE HARTFORD PLANT.

The first sludge digestion plant in Wisconsin was constructed in Hartford to replace an old rectangular sedimentation tank which had been in service for ten years. Hartford is located on a small stream tributary to Rock river, which has a minimum flow of 3.2 cubic feet per second and is required not only to dilute the effluent from the city disposal plant but also to carry a heavy load of industrial waste. The Wisconsin State Board of Health makes an annual examination of the city's disposal plant and credits it with having given excellent results, although its report called attention to the necessity of giving the effluent further treatment because of the polluted stream condition.

The sewage in coming to the disposal plant first passes through a bar screen, which consists of flat bars spaced one-half inch apart and set at an angle of 45 degrees. The screenings are removed twice daily by raking and are either buried, burned or deposited on the sludge bed. The sewage then passes through a clarifier, which is a square concrete tank with a center depth sufficiently greater than the side depth to permit a sloping bottom toward a central cone. This is supplied with a Dorr clarifier, which continuously scrapes the sediment to the center, from which it is pumped by a sludge pump located in a

*President Jerry Donohue Engineering Company, Sheboygan, Wisconsin.

FIG. 2—ANTIGO PLANT IN OPERATION, DECEMBER, 1926.
Temperature 15 degrees below zero. Sludge in digester at left is maintained at 60 degrees by heating coils.

pump room adjacent to the clarifier and driven by a motor to which it is connected by a silent chain drive. The detention period in the clarifier ranges from 1¾ hours to 3¾ hours.

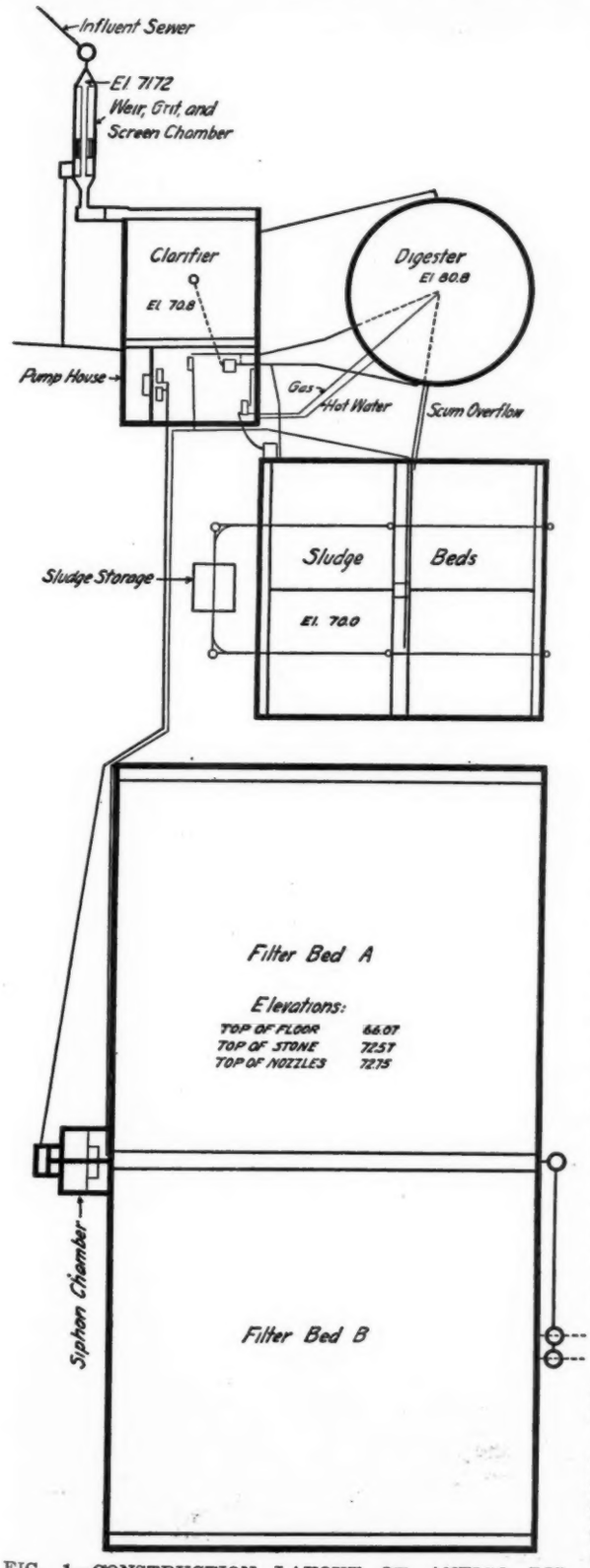


FIG. 1—CONSTRUCTION LAYOUT OF ANTIGO DISPOSAL PLANT.

It has been found that the sludge pump should be operated at intervals, each time just long enough to remove the accumulated sludge. At first there was a tendency to run the sludge pump for too long a period, which resulted in pumping fresh sewage into the digester and also caused pump trouble. It was found that this could be entirely avoided by pumping only from twenty to thirty minutes a day, depending upon the relative capacity of clarifier and volume of sewage flow. The night flow of sewage is permitted to pass through the clarifier, the sludge accumulated during the night being pumped in the morning when the operator starts the plant.

The sludge digestion tank is a circular concrete tank so arranged in elevation as to permit sludge to be discharged from it onto a sludge drying bed. Suspended in the digester is a mechanism which revolves and keeps the sludge in continuous motion and the scum broken up so that gases may escape. The incoming sludge from the Dorrco pump is distributed over the surface by means of a channel which rides with the circulating mechanism.

THE ANTIGO PLANT.

The most recent separate sludge digestion plant in Wisconsin is that put into operation last winter at Antigo. This replaces an old sedimentation tank type of plant which was a continual source of trouble to the city. Upon several occasions land owners on the streams below Antigo sued the city and collected for damages to their property as riparian land owners.

In addition to mechanical agitators as used in the Hartford plant, the Antigo plant has other new features, one of them being a means of collecting and utilizing the gases from the digesting sludge. The digester has a tight cover made up of a reinforced concrete slab which is joined to the side walls in such a manner as will permit expansion and contraction without opening a crack and allowing leakage. In the center of the roof is a steel gas dome into which all the gases escaping from the digesting sludge are collected. From this gas dome the gas is piped to a gas burner in the pump room where it is used as a fuel for heating the building and the sludge in the digester. It was calculated that the amount of gas that would be available was equivalent to one-third cubic foot per capita a day, and the amount already developed in the Antigo digester confirms the original estimate. This gas is being passed through a meter and an accurate record is kept of the amount of gas developing in the digester. The Antigo plant was put into operation when the outside temperature was 18 degrees below zero, but under these adverse conditions it is functioning very satisfactorily.

The effluent is passed through sprinkling filters, giving this small city a complete sewage treatment plant.

In order to stimulate digestion and lengthen the period of digestion, heating coils were inserted in the digester, which coils are connected to a heater in the pump room. The heater circulates hot water through the coils, thus increasing the tempearture of the sludge. The temperature of the incoming sewage is 52 degrees both summer and winter. During the

FIG. 3—ANTIGO CLARIFIER AND PUMP HOUSE UNDER CONSTRUCTION
Note plows suspended from mechanism at bottom of pit.

cold weather of last winter the temperature of the mass of sludge in the digester never fell below 60 degrees. The accompanying photograph shows the method of connecting the heating coils. They are supported to the inside wall of the digester and extend around the inside circumference. The bottom coil is sixteen inches above the floor. They are connected into a header on each end, as shown in the illustration.

COST OF OPERATION.

The cost of operating separate sludge digestion plants is considerably lower than engineers first estimated. Actual cost records kept at Hartford show that a total of 5,179 k. w. h. were used at a cost of $259, which is equivalent to 79 cents per day. This includes the total power consumed in operating all the motors and operating the plant. The amount of labor necessary to run the plant for the entire year cost approximately $350, making a total annual operating charge of $629. The second year's operation showed a reduction in power cost to 50 cents per day, this being occasioned by decreasing the time of running the sludge pump. The first year's experience demonstrated the desirability of running the pumps for only a short period of time each day. The actual cost of current is now fifteen dollars per month, which reduces the total annual operating charge against the plant to $535. Comparing the cost of separate sludge digestion with the two-story Imhoff type, we found the construction cost to be actually 72 per cent. of the estimated cost of the two-story type, including both sedimentation and digestion units. Part of this saving is occasioned by the fact that the two-story type would require deep excavation in treacherous soil. The sludge digestion type requires only shallow excavation, and the fact that the sludge is elevated by pumping permits the digester and sludge pump to be located above ground if conditions require.

Comparing the efficiency of sludge digestion with the two-story type, we feel that on account of continuous attention the efficiency of the separate sludge type is at least equal to the Imhoff plant. The actual accomplishment in removal of solids as reported by the Wisconsin State Board of Health at Hartford was 73 per cent. of the suspended solids removed. A test at Antigo for seven days, taking hourly samples both day and night, showed a removal of 55 per cent. The percentage of removal during the day when the amount of solids was much greater corresponds to the figure given above for Hartford.

The following is a summary of the advantages of Separate Sludge Digestion over the other types of sewage disposal:

(1) The first cost of construction is less on account of shallow excavation and the possibility of locating practically all of the structures above ground.

(2) The systematic continuous operation made possible by the Dorr mechanisms increases the efficiency of the plant itself.

(3) This type is more flexible inasmuch as the plant when first built does not limit the relation between clarification and digestion.

(4) The elevation of the digester permits the sludge to drain by gravity to a well underdrained bed. (See photograph No. 5.)

(5) Separate sludge digestion permits the collection of gases which, when burned, eliminates

FIG. 4—ANTIGO PLANT UNDER CONSTRUCTION
Taken before fill was placed around digester. Digester 15 feet deep. Note concrete cover over it.

FIG. 6—HEATING COILS IN ANTIGO DIGESTER
Six coils made up of 2-inch galvanized pipe. All metal parts were painted with biturine.

odors and conserves fuel that may be used about the plant. This is especially advantageous in Wisconsin where the climate varies from 100° in the summer to 30° below zero in the winter, and where it is almost necessary to increase the time of digestion by heating the sludge and not depend upon warm weather for this heat.

(6) Experience with these plants demonstrates the value of mechanical operation and emphasizes the importance of intelligent operation. A sewage disposal plant should be as carefully operated as a water works pumping station, and the sooner the people realize and recognize the importance of this problem the sooner will it be possible for us to restore our lakes and streams to their natural beauty and purity.

B. J. Hartman, of the Jerry Donohue Engineering Co., has had charge of the design of the separate sludge digestion plants built under the superviison of this company. The Antigo plant was built by the Manitowoc Construction Co. Frank Quimby had charge of the construction, and as city engineer of Antigo he is now in charge of the operation of the plant.

Road Maintenance in Norristown

By S. Cameron Corson*

Engine cinders, preferably of hard coal, have been used for many years in Norristown, Pa., for street work. Some streets with a natural red shale base, although almost impassable in the Spring during the wet season, have been made hard and durable by spreading engine cinders on the surface. These seem to have an affinity for the shale, and, after rolling or dragging, give a surface that is infinitely better than any other form of cheap road surface. However, even this type of dirt and cinder road must be watched and additional cinders added until there are no ruts or disintegrated places.

In several cases, when a Tarvia macadam surface had been ordered to replace the old cinder shale surface, a road rooter, drawn by a ten-ton roller, was

*City engineer, Norristown, Pa.

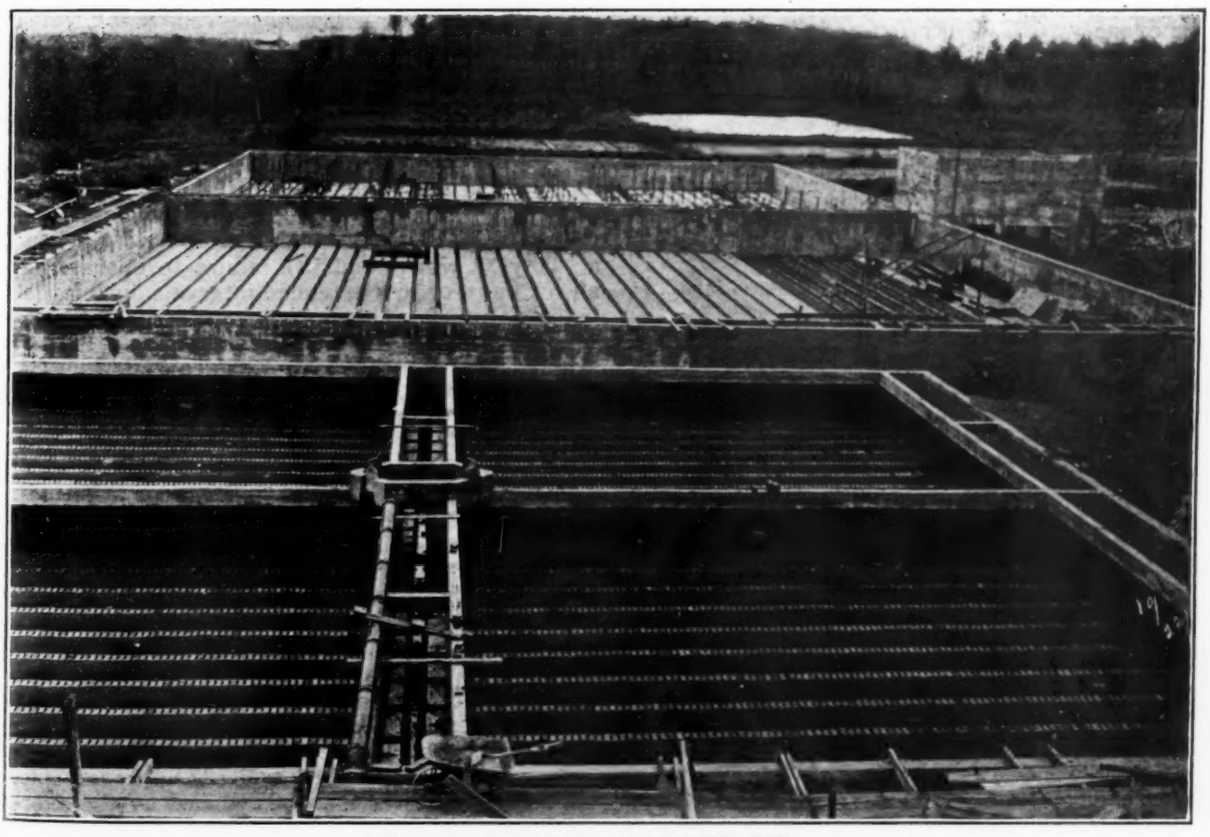


FIG. 5—SLUDGE BED AND FILTER BED.
Both sludge and filter beds are underdrained with Rawn tile. Drainage and aeration permitted by slots between vitrified brick. All concrete below air line is treated with asphalt to protect concrete from acid action. Sprinkler nozzles shown in far filter. Siphon chamber at right.

not able to penetrate the crust, and it was broken up only after picks had been placed in the roller. It is evident that we had made inadvertently a combination of cinders and shale, which, to my knowledge, had never hitherto been made. Just what proportions are necessary are immaterial, because with other subsoils, such as yellow clay, soft sand, stone and clay mixed, and soft red sandstone and red shale mixed, surface treatment of engine cinders with a high crown gave us the same results.

I have not used this method on loam or garden soil but I have been informed that truckers in this vicinity have obtained splendid results with engine cinders spread ten or twelve feet wide to make a road over their truck patches. Three and 5-ton trucks pass over these roads.

A high crown is always used. For a 12-foot roadway, the crown is about 3 inches. The cinders are spread to a uniform depth of about 6 inches, but deeper where conditions demand. It is not the intention to use the cinders alone for the surface, but to amalgamate them with the soil. Occasionally the surface is scarified, in order to get a better mix, and rerolled.

In 1925 and 1926 some of these cinder streets were covered with a one-inch layer of three-quarter inch limestone, and one-third to one-half gallon of liquid asphalt per square yard applied. Over this was spread enough limestone chips to prevent the asphalt being picked up by the roller, and the surface was then thoroughly rolled. This gave a splendid surface at a cost of 35.3 cents per square yard. Limestone was $2.00 per ton and limestone chips $2.20. In all, 87,285 square yards were treated in this way.

Forest Avenue, a cinder covered road on red shale, had withstood heavy truck traffic for three years, but had caused considerable nuisance from dust. It was covered with asphalt and stone, at the following cost:

78.2 tons ½-inch chips @ $2.20	$172.04
101.5 tons ¾-inch limestone @ $2.00	$203.00
2,000 gallons liquid asphalt @ .14¾	$295.00
Labor, trucks, rolling, etc	$246.00
	$916.04

The total area covered was 2,112 yards, and the average cost 43 cents. A few places have raveled since the work was completed, but the raveled area does not amount to 3 per cent. of the total.

Street Traffic Signs to Be Standardized

A committee of the American Engineering Council, cooperating with the Hoover National Safety Council on Street and Highway Safety, the National Safety Council and other interested bodies, is now undertaking a comprehensive study of the subject from which it is hoped that a national standard in street marking and traffic signs can be evolved. The following will be covered.

Pavement markings; street traffic signs; automatic traffic signals; safety zones and islands.

The committee will first gather detailed information on present practices, through the co-operation of representatives in each important city, and after studying such data will prepare a report including recommended standards for the purpose of bringing about uniformity in traffic control as far as is practicable and desirable.

W. B. Powell, traffic engineer, Buffalo, is chairman of the committee; Sidney J. Williams, National Safety Council, is vice-chairman; the other members are M. G. Lloyd, Bureau of Standards; E. P. Goodrich, consulting engineer; Ernest N. Smith, American Automobile Association; Thos. Fitzgerald, Pittsburgh Street Railway Company; A. B. Barber, U. S. Chamber of Commerce, and L. W. Wallace, American Engineering Council.

Time Losses in Concrete Road Construction*

Reported by Andrew P. Anderson, Highway Engineer, United States Bureau of Public Roads

Data accumulated by the Bureau of Public Roads during the past two years indicate that the average concrete paver on state road construction does not reach an average of 1,000 hours of actual mixer operation per season, even when supplied with ample work under contract. Where contracts are short or conditions unfavorable, mixers may not exceed 500 hours actual operating time. The possible available working time is estimated as 2,000 hours per season, except for rather limited areas in the extreme South, where it is greater, and for some Northern areas where it may not exceed 1,500 hours.

The failure of mixers to be engaged in actual work for more than about 53 per cent. of the time is held to be due to a large number of reasons which may be grouped under two main classes: (1) Slow or inefficient operation when actually at work; and (2) failure to operate at all for more or less extended intervals during the working season. The more general term of "time losses" is applied to this second class. In the studies here reported, only definite cessations of mixer operation, each of 15 minutes or more in duration, have been classified as time losses. All the innumerable stops of less than 15 minutes each have been considered as the result of slow and inefficient operation.

The first kind of losses encountered are those involved in securing the contract and getting onto the job. These losses, though undoubtedly great, are unknown. The studies herein reported cover only the more tangible losses occurring after the arrival on the job in the spring, and until work is discontinued in the fall.

Table 1 shows the percentage of time lost on account of various causes on thirty-two projects.

Time losses may be divided further into two groups: (1) preventable; and (2) unpreventable. Preventable losses may be reduced by the exercise of forethought and usually at some cost. The problem is one of balancing probable losses

*Abstracted from "Public Roads," the official publication of the U. S. Bureau of Public Roads.

TABLE 1--Percentage of total available working time lost on account of various causes on several projects

Project No.	State	Dates (inclusive)	Total time losses	Weather losses: Rain and wet subgrade	Weather losses: Cold weather	Moving	Subgrade not prepared	Hauling equipment	Lack of material	Mixer trouble and repairs	Water	Time limit on fills	Finishing	Loading plant	Miscellaneous
1	Texas	Mar. 24 to June 2	60.3	39.3	..	3.0	10.5	2.3	1.5	0.6	0.8	..	..	..	2.3
2	Oklahoma	Oct. 27 to Nov. 19	44.7	13.5	10.7	9.4	.8	..	..	..	6.0	..	..	2.5	1.8
3	Texas	Mar. 1 to Apr. 30	49.7	45.5	..	..	1.3	..	.9	.6	1.4	..	..	..	..
4	Missouri	Apr. 7 to June 6	40.3	28.8	..	1.0	1.1	5.3	..	.9	..	..	..	..	3.2
5	Missouri	May 2 to July 31	43.5	30.0	..	1.9	5.0	2.2	..	.3	..	..	0.7	..	3.4
6	Missouri	May 27 to July 31	38.8	23.9	..	1.8	8.5	.8	..	..	1.3	..	1.0	..	1.5
7	Missouri	July 10 to July 31	44.7	9.3	..	..	..	27.5	..	1.4	..	..	1.5	1.8	3.2
8	Missouri	Apr. 22 to Sept. 18	29.8	21.6	..	6.2	..	.4	..	..	..	..	..	..	1.6
9	Missouri	Aug. 1 to Aug. 25	36.0	25.6	..	..	5.8	..	..	..	..	..	..	..	4.6
10	Missouri	Aug. 18 to Aug. 27	29.4	17.3	..	9.8	..	..	.	1.4	..	..	..	..	.9
11	Nebraska	Sept. 14 to Sept. 30	25.0	23.7	..	..	..	..	..	..	..	..	..	..	1.3
12	Missouri	Aug. 10 to Nov. 19	45.8	25.6	3.9	4.0	1.3	..	..	2.1	.9	..	..	7.1	..
13	Missouri	June 12 to Nov. 24	48.4	29.6	2.6	6.3	2.8	3.0	..	1.7	.4	..	..	..	2.0
14	Missouri	Oct. 9 to Nov. 24	62.9	36.0	..	..	15.4	.8	..	.5	4.2	..	..	..	6.0
15	Illinois	Apr. 30 to Nov. 7	48.5	21.1	2.5	4.1	2.6	4.5	1.1	5.3	6.0	..	..	..	1.3
16	Illinois	May 18 to Nov. 6	53.6	19.8	.2	12.8	2.0	8.7	..	5.2	.5	..	..	..	4.4
17	Illinois	May 18 to Nov. 5	46.7	13.3	5.1	12.9	.8	10.4	.5	2.6	1.1	..	..	..	..
18	Florida	Oct. 9 to Jan. 19	64.4	12.9	1.1	..	30.8	2.7	..	..	1.1	9.7	..	..	6.1
19	Florida	Apr. 25 to Jan. 28	44.8	17.6	..	6.3	1.9	1.1	8.6	5.5	1.3	..	.3	..	2.2
20	Mississippi	Oct. 24 to Dec. 7	57.9	23.0	..	..	11.4	..	7.7	3.0	3.1	..	.6	6.0	3.1
21	Texas	Apr. 16 to July 31	51.8	14.9	..	2.4	4.0	2.9	10.7	10.5	2.5	..	..	.5	3.4
22	Texas	June 15 to July 11	58.0	35.8	..	5.9	1.9	1.3	9.8	.4	.5	..	..	..	2.4
23	Texas	June 17 to Aug. 1	41.6	3.5	..	..	19.2	3.3	..	.2	.4	..	..	11.0	4.0
24	Texas	Aug. 9 to Aug. 21	64.1	26.1	..	..	24.6	..	..	1.3	.6	..	..	..	11.5
25	Missouri	May 24 to Sept. 25	55.8	29.6	..	7.5	3.6	.3	..	2.3	9.6	..	1.0	.1	1.8
26	Michigan	June 7 to Sept. 11	34.0	10.3	..	1.8	3.2	5.8	1.3	1.7	.1	..	.3	3.7	5.8
27	Michigan	June 14 to Sept. 11	48.4	15.8	..	..	3.6	7.9	13.5	.5	.9	..	..	.2	6.0
28	Michigan	June 21 to July 10	26.0	.3	..	..	8.0	1.9	..	.8	3.5	..	7.3	..	4.2
29	Missouri	June 14 to Sept. 4	55.0	24.7	..	..	..	20.4	2.4	3.6	1.5	..	.5	..	1.9
30	Oklahoma	June 14 to July 17	28.9	20.7	..	..	1.6	..	5.0	..	..	..	..	..	1.6
31	Oklahoma	June 21 to July 31	35.0	16.8	..	8.9	1.3	.5	1.8	1.4	1.6	..	.1	..	2.6
32	Oklahoma	Aug. 9 to Sept. 11	50.1	16.0	..	2.1	.4	.3	7.3	.4	6.0	13.1	..	3.7	.8
		Average	47.4	21.5	1.1	4.8	4.3	4.1	3.0	2.6	1.8	.5	.2	.6	2.9

against probable gains. A study of the losses shown in Table 1 shows that there are certain probable losses that have a sufficiently high probability to be worthy of study. The most common and serious losses shown were from rain or wet subgrade, but all weather losses together, and the moving loss, which is generally unavoidable, account for only little more than half the total delay. Of the other troubles, which are largely avoidable, the most serious were those caused by lack of prepared subgrade, by insufficiency or breakdown of hauling equipment, by lack of materials, and by mixer and water troubles. Of the 32 projects listed in Table 1, 27 suffered in greater or less degree from lack of prepared subgrade, 23 from lack of hauling equipment, 14 from material shortage, 25 from mixer trouble, and 24 from water trouble. An analysis of time losses on one job is shown in Table 2.

TABLE 2—Analysis of time losses during the working season on one job from May 25 through September 25, 1926*

	Hours	Mins.
Total time mixer operated during the construction season	447	50
Time lost in avoidable delays:		
Water trouble: Old water pumps; old 2-inch pipe line and inadequate supply of pipe line	87	30
Preparing the fine grade ahead of and in the rear of the mixer	62	3
Truck shortage	32	35
Improper subgrade drainage	35	30
Mixer trouble	19	0
Making unnecesary move with paving outfit	17	0
Repairing old, worn-out subgrade roller	9	30
Poor engineering and inspection	9	0
Using old forms that would not support the finishing machine	7	55
Getting late start in morning	5	40
Miscellaneous delays	4	12
Outfit stopped work for an expected rain; no rain came	2	45
Setting up new finishing machine	2	30
Using 2 old worn-out finishing machines	1	40
Loaders at loading plant		45
Total avoidable delay	297	35
Total time mixer should have operated during the construction season	745	25
Time lost in unavoidable delays:		
Wet subgrade due to previous rain	297	25
Rain during working hours	53	0
Moving outfit to new location	54	15
Mixer, mechanical trouble	13	10
Miscellaneous delays	1	15
Total unavoidable delay	419	5
Total number of working hours in construction season from May 25 to Sept. 26, 1926 (average length of working day, 10 hours 30 minutes)	1,164	30
Total production during construction season		Miles 8.56

*Delays of less than 15 minutes duration occurring during the hours that the mixer was in operation are not shown in this analysis.

There are therefore three important questions confronting the contractor: (1) The kind, persistence, and extent of his time losses; (2) the cost of such losses; and (3) the cost and probable effect of the measures which may be adopted to eliminate or reduce the loss.

The cost of time losses varies of course. In the average road job where the mixer operates around 1,000 hours a season, the fixed cost will probably run $15 to $20 per hour. If the mixer is operated only 500 hours a season, the fixed cost will be twice as great per hour. With fixed charges so heavy there is little left for profits, and the necessity for the profitable use of every hour of available time is clear, as it represents a considerable gain to the contractor.

Some kinds of time losses are more expensive than others. Interruptions to actual production, such as delay in the delivery of materials to the

mixer or waiting for subgrade, or for the repair of a break in the water line, usually involves full time payment of the entire crew; whereas full or half-day lay-offs due to rain, wet subgrade, or serious breakdowns, usually involve only the full-time payment of a small part of the personnel. If such layoff is not too protracted, it may be less expensive than the numerous short time interruptions which occur during the working day. But if the lay-offs are prolonged, men become dissatisfied, and a disruption of the organization may occur. Production rarely proceeds at full rate the first day after a protracted period of idleness. Sometimes the effect is apparent for two or three days.

Good management can reduce the avoidable time losses in many ways. To some extent modern management methods have been used to guard against delay, as in the advance ordering of materials. The data assembled by the Bureau of Roads point clearly to other fields where modern management methods can save money. For instance, on many jobs a small amount of subgrade drainage would yield high returns. The job shown in Table 2 suffered a total loss of 386 hours due to rain and wet subgrade, but rain fell only during 53 hours. A loss of about $1,200 because of failure to provide about $50 worth of labor to open drains into side ditches was indicated here. Proper maintenance by experienced men of roads over which materials are hauled would go far in lowering time losses caused by insufficiency of the hauling equipment.

Moving from one set-up to another during the working season seems to consume much more time than is generally believed. The average for all the jobs studied during the past two years was 10.1 per cent. of the total time losses, the second largest item on the list. Sometimes more moves are made than conditions really warrant, and the amount of time consumed in making them is so large that a considerable reduction should be possible when the contractor fully understands the actual, monetary loss incurred every day his equipment is non-productive. In selecting equipment one of the factors which should be given careful consideration is that of mobility or ease of dismantling, transporting and reassembling, not only of individual units but also for the entire plant. The various details of the entire operation of moving should be planned as carefully as the operations involved in the placing of the concrete.

Waiting for the subgrade to be prepared accounted for 9 per cent. of the total time losses on the projects studied. These losses should be possible of entire elimination. With very few exceptions they are wholly chargeable to poor management. On the average job, as shown by these studies, their entire elimination would be worth from $2,000 to $3,000 per season—a sum more than sufficient to pay the difference in salary as between a poor and a good superintendent.

The remaining time losses, such as those due to poorly operated or insufficient hauling equipment, mixer trouble, lack of materials at the supply yard, water supply, and the various miscellaneous causes, all of which comprise about 33 per cent. of the total average time losses or about 16 per cent. of the total available time, are also very largely a question of management. Few, if any, of these losses can be entirely eliminated without incurring excessive expenditures. But there would seem to be little reason to doubt that all can be reduced and some very materially. This is shown so clearly on the observed jobs on which the management was of an especially high order as to be subject to little or no question.

Rainfall, and its effects on the subgrade and the road or track over which materials are hauled together with frost and cold weather, was the cause of nearly one-half the average time lost on all jobs studied. These losses naturally vary greatly from job to job. A sandy or gravely porous soil will dry far more quickly than a heavy clay or silt. The amount and distribution of rainfall also varies greatly from place to place and season to season. No constant relation between rainfall and time lost because of rain or wet subgrade may be expected. Data on various jobs under different conditions show 12 to 19.4 hours lost per inch of rainfall.

Fall weather losses are usually large. The contractor who permits possible hours of summer operating time to escape and plans to operate a little later in the fall is against heavy odds. Table 3 gives the time losses on a number of fairly typical jobs for the months of July and October. Time losses in October averaged 64 per cent. as against 35 per cent. in July. This difference is due almost entirely to time losses caused by rain, cold weather, and wet subgrade.

Although the data herein presented are not sufficient to warrant definite conclusions, they do indicate that certain very similar conditions

TABLE 3—Time losses, in hours, in summer and fall

Project No.	Dates (inclusive)	Available working hours: Mixer in operation	Available working hours: Mixer idle	Lost time: Rain, wet subgrade, etc.	Lost time: Moving	Lost time: Subgrade not prepared	Lost time: Hauling equipment	Lost time: Lack of materials	Lost time: Mixer trouble or repair	Lost time: Water	Lost time: Cold weather	Lost time: Finishing	Lost time: Miscellaneous
13	July 1 to 31	212.5	74.5	46.0	..	..	2.0	..	16.0	..	..	2.0	8.5
	Oct. 1 to 31	76.0	215.0	171.0	..	..	1.0	..	3.0	..	40.0	..	..
19	July 1 to 31	188.5	72.0	28.0	..	10.75	2.75	21.75	4.75	53.0	..	1.0	..
	Oct. 1 to 31	117.5	146.0	39.0	38.0	1.0	22.25	28.0	9.5	2.0	..	0.75	5.5
15	July 1 to 31	186.0	99.0	12.0	53.0	13.0	10.0	..	2.0	8.0	..	..	1.0
	Oct. 1 to 31	134.0	265.5	150.0	32.0	..	..	..	36.5	..	47.0	..	..
16	July 1 to 31	155.0	142.0	22.0	69.0	..	29.5	..	21.5	..	..	..	..
	Oct. 1 to 31	110.5	206.5	127.0	20.5	9.0	13.0	..	8.0	..	3.0	..	26.0
17	July 1 to 31	165.75	104.25	..	66.75	..	25.75	..	7.75	4.0	..	..	..
	Oct. 1 to 31	118.0	169.0	79.0	10.0	..	17.0	..	..	..	63.0	..	..
Grand total		1,463.75	1,493.75	674.0	289.25	33.75	123.25	49.75	109.0	17.0	153.0	3.75	41.0
Total for July		907.75	491.75	108.0	188.75	23.75	70.0	21.75	52.0	15.0	..	3.0	9.5
Total for October		556.0	1,002.0	566.0	100.5	10.0	53.25	28.0	57.0	2.0	153.0	0.75	31.5

exist on many projects, and that these conditions have a tremendous influence on the actual cost of the completed work. They indicate also that nearly half of the average time losses are due to causes which are or can be made subject to the control of the contractor. With increasing skill and ability in management we may expect to find this type of time loss reduced in the future. The other half of the losses due directly and indirectly to adverse weather conditions it is clearly impossible to eliminate entirely and such losses are therefore amenable only in part to managerial control. All of the data so far assembled, however, seem to indicate that a goodly proportion of the time lost now as the direct or indirect result of rainfall is not inherent in the nature of the physical conditions, but rather, at least in part, is due to difficulties inherent in or connected with the present methods of operation and management. Therefore as the probability ratio of the various forms of loss and the financial burden they place upon the contractor become better known, the faults of our present means and methods will surely be corrected.

If, under certain conditions, we find that on the average $50 worth of attention to surface drainage of the prepared subgrade is reasonably certain to save for productive operation time worth 20 times that expenditure, then the needed attention to surface drainage will be readily forthcoming. Similarly, if proper attention to the maintenance of the road over which the hauling is done can be shown to yield certain profits above its cost, then such maintenance will become a regular part of the hauling plan. On one point, the data obtained are probably conclusive and that is that under anything like identical conditions the time lost will vary inversely with the ability of the management.

Lighting Country Highways

In planning the "Ideal Section" of the Lincoln Highway in Lake County, Indiana, it was considered that ideal conditions would include lighting, and this section, one and a half miles long, contains lighting units throughout its length.

The Lincoln Highway Association installed these lights and for a considerable time maintained them through an arrangement made with the Northern Indiana Gas & Electric Co. However, last September the Association felt that it should no longer be called upon to maintain the lighting and discontinued doing so, it being understood that the town of Dyer would take over the maintenance of the system.

During the time the association maintained the system, it cost a flat figure of $132.80 per month, which included renewal of burned out globes and any other ordinary maintenance work.

In writing us on the subject C. S. Hoag, secretary of the Lincoln Highway Association, states that the association advocates the lighting of all main trunk highways and believes that this should be done by the same political unit that constructs and maintains the individual sections of the highway. In other words, it believes that lighting is just as much a part of the maintenance of the road as is the repair to the same, the cutting of grass, or any of the work that is necessary to make the road travelable; and that if State Highway Departments were so inclined, they could legally install these lighting units and maintain them under their ordinary maintenance budget.

It is believed that some, if not all, public service corporations would be very glad to make the lighting installations along the highways, amortizing the cost over a period of years. For where the highways are lighted, the necessary wiring allows them to provide current for farm purposes along the route, the returns from which would finance the placing of wires along the highway, which is the most expensive part of the installation.

For the illumination of the Lincoln Highway, General Electric Company highway lighting units are used, spaced 250 feet centers, staggered, the distance from the road surface to the light center of the lamp being 35 feet. They are mounted on concrete standards placed along the outer edges of the gravel shoulder. The circuit is buried twelve inches underground, using No. 8 D & S solid conductor with rubber insulation and lead sheath having a band-steel armor. It is laid without a conduit except where it crosses two roadways, where three-inch conduits are used.

Lights have been installed along about fifteen miles of a road in Gogebic County, Michigan, between Ironwood, Bessemer and Wakefield. C. F. Winkler, engineer of the County Road Commissioners, gives us the following information concerning this installation. This road is the only East and West road through this mining territory and consequently carries considerable local traffic as well as all through traffic. The road also traverses several mining locations in addition to the cities named; as a result of which there are many pedestrians on the highway. The road is paved about 75 percent of the distance with penetration macadam, making a very black background, and 25 percent with concrete. The pavement is 18 feet wide on a 24-foot road bed and carries from 1,500 to 4,000 vehicles per day. Because of the narrowness and the blackness of the road and because of the great number of pedestrians, it was decided that highway lights would be a benefit. The standard Westinghouse units were installed on cedar posts about 30 feet high and about 25 feet from the center of the pavement, 14 or 15 lights to the mile. Special attention was paid to place lights properly at both vertical and alignment curves. The poles carrying the lights also carry 5 ft. 7 in. cross arms, the two outer ends of which are used for two No. 8 wires. The lights are wired in groups, using 5, 7½ and 10 kw. pole type regulators and are controlled either with a time switch or with an RCOC remote control switch. The standard Westinghouse highway lighting units were used, with 250 c.p., 6.6 ampere series lamps.

Power is obtained from a local power company, the rate paid being $3.75 per month per light for lighting from dusk until 1 o'clock A.M. The money is raised by direct taxation and is pro-rated between the county, the cities, and the townships through which the road passes. Seventy-five percent of the cost is paid by the county and the remaining 25 percent by the other municipalities. The cost per

light may seem high, but the installation cost on the fifteen miles of road was a large item.

Mr. Winkler says that since installing the lights the number of accidents to pedestrians has been reduced to almost zero. In 1925, the first year of the lighting experiment, only one person was killed and there were only a few minor injuries; while motor car accidents decreased 20 percent in 1925 as compared to 1924. He also believes that the lights are assisting materially in building up the territory adjacent to the highways. Many new homes are being erected on the outskirts of the towns. It is certain that walking between towns and locations is safer, as not only are pedestrians easily visible from cars but the lighted way is safer and more comfortable for those who must walk the roads at night. The records also show that the number of motor car collisions due to poor visibility in rain or fog has been greatly reduced.

Record for Locating Valves and Services

The necessity for accurate records showing the location of valves and services was stressed at the latest meeting of the North Carolina Section of the American Water Works Association. McKean Maffit, superintendent of the Wilmington (N. C.) Waterworks, cited several instances showing the worthlessness of location records based on such marks as fences, house corners and house lines. The fallibility of the old foreman who "could come to the place ten years later and put his foot on any valve" (but failed in the test) was mentioned.

Records for valves in Wilmington are now based on street intersections. James E. Gibson of Charleston, S. C., stated that the universal practice in that city was to put valves on the property lines, and lay mains a certain fixed distance from the curb line.

Side Hill Work In San Francisco

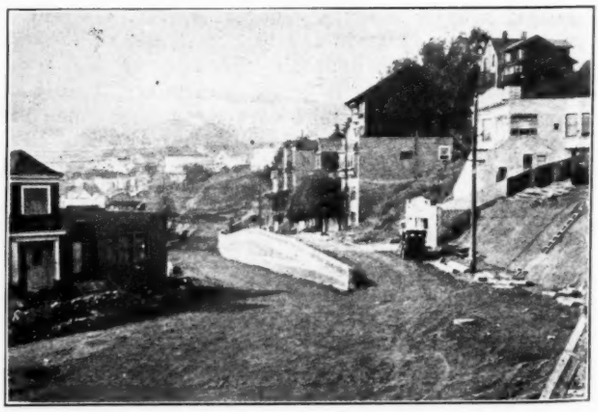
Due to heavy slides on the precipitous slopes of Sutro Heights, San Francisco, overlooking Point Lobos avenue, trimming of the slopes and construction of a rubble wall was thought necessary by Park Superintendent McLaren. This wall as built was approximately 190 feet long and 15 feet thick at the base, tapering at a height of 175 feet to 50 feet in length. The boulders forming the slope wall were interlocked and the interstices packed with clay. A heavily tamped fill of clay was put behind the wall and the surface of the fill smeared with oil to prevent seepage of water back of the wall.

Sliding also had occurred into the roadway encircling the park near the summit of the Heights, and to preserve the roadway at this point a reinforced concrete roadway slab and parapet wall supported on heavy beams and columns was constructed on the west side over a length of 108 feet. The supporting beams and columns were anchored into solid rock on the hillside.

The development of the hillsides of San Francisco for building purposes require many ingenious combinations of grades, retaining walls and ramps, etc. each case being practically a new problem. The two illustrations shown herewith illustrate two such locations. In one of these, two streets climbing the hillside are shown combined and connected with a third by a short double hairpin curve, the turn being so short that retaining walls were necessary for holding the embankment of the road above. In the other illustration is shown a side-hill street in which the houses on the upper side are considerably higher than those on the lower and the street is consequently divided into two levels separated by a retaining wall.

RUBBLE WALL AT SUTRO HEIGHTS

SIDE WALLS AND RAMP CONNECTION AT JUNCTION OF ROOSEVELT WAY WITH LEVANT AND STATE STREETS



RETAINING WALL AND DOUBLE ROADWAY SERVING UPPER AND LOWER ELEVATIONS ON SIDE HILL

Distribution of Cellulose in Imhoff Tanks

Cellulose content of fresh sewage solids collected from the different compartments of an Imhoff tank. Long tanks ve. deep ones.*

H. Heukelekian†

INTRODUCTION

Cellulose being one of the important constituents of the organic matter of sewage, it would be of interest to know what percent of the organic matter of a normal sewage it constitutes, and if any local and seasonal fluctuations exist in respect to its cellulose content. Although at present sufficient data are not available to elucidate the last point it was deemed advisable, because of the paucity of such data, to report the results thus far obtained as to the cellulose content of fresh sewage solids and the variation of cellulose content of fresh solids received at the different compartments of an Imhoff tank.

It has been generally known that the amount of material received in the inlet end of an Imhoff tank is much larger than that in the middle or outlet end. It might have been intimated that there is a possible difference in the composition of the material settling at the different compartments, but no figures seem to be available.

METHODS

The fresh solids were collected by sinking pails in the different compartments of the flow channel of an Imhoff tank at Plainfield. At the end of 24 hours a sample was taken from the material collected in each of the three pails and then the rest of the material from the three compartments was mixed thoroughly and a representative sample taken. Solids, ash and cellulose determinations were made on these samples. The method of cellulose determinations is given in another paper (1).

DISCUSSION OF RESULTS

Table 1 gives the results of solid concentration, volatile matter content and cellulose content of the materials taken from the inlet, middle and outlet end of an Imhoff tank and also of the mixed material.

Table No. 1

Compartment	Solids		Vol. Matter	Cellulose in Solids	Cellulose in Vol. Matter	Increase or Decrease of Vol. Matter	Increase or Decrease of Cellulose
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Inlet ..	6.25	20.3	4.98	7.72	9.70	15	15.3
Middle .	4.99	20.5	3.96	3.40	4.30	—9	—48.8
Outlet .	4.04	23.2	3.10	2.83	3.70	—29	—56.1
Mixture	5.56	23.3	4.32	6.53	8.41	—	——

Before comparing the three samples from the different compartments, a few words should be said as to the cellulose content of the mixture which can be taken as an average figure for solids received at this plant. It will be seen that on the basis of solids the cellulose content is 6.53%, while on the basis of volatile matter the cellulose content is 8.41%. The following figures show how much of the volatile matter in the fresh solids is still unaccounted for.

	Fresh solids	*Ripe sludge*
Volatile matter	67%	57.3
Proteins (3.39% N X 6.25)...	31.6%	43.1%
Ether extract	19.5%	12.4%
Cellulose	8.4%	....
	59.5%	55.5%

The figures for proteins and ether extract are taken from an average analysis of the fresh solids and ripe sludge as reported in the 1923 report from this laboratory (2). The figures are calculated on the basis of the volatile mtaerial.

The calculation of proteins from the total nitrogen figures is of course a mere approximation. The 7.5% of the organic matter in fresh solids not accounted for by the proteins, ether extract and cellulose can be explained easily on the basis of the starches, pentoses, hexoses and lignins which are undoubtedly present in the fresh solids.

In the case of ripe sludge, the proteins and the ether extract can explain 55.5% of 57.3% volatile material. This would indicate that cellulose is not present in the ripe sludge and that the cellulose of the fresh solids must be decomposed. This is the case, as will be shown in another paper (1).

In comparing the cellulose content of the material from the inlet, middle and outlet compartments, as given in table 1, it will readily be seen that the solid content is highest in the inlet compartment and lowest in the outlet. It is of interest to note that the percent ash of the solids in the inlet end is not higher than that of the outlet. It might have been expected that the material at the inlet end would contain a greater percentage of grit and inorganic residue, but the ash content of the material does not change materially with the solid concentration and the differences observed in the cellulose content on the basis of volatile matter must be due to a greater relative concentration of cellulose in the organic matter. This is the case with the material in the inlet compartment, which has a cellulose content of 9.70% on the basis of volatile matter, while samples from the middle and outlet end have 4.30 and 3.7% respectively. The cellulose content of the middle compartment is nearer to that of the outlet end than to that of the inlet. Actually then, cellulosic material settles at a

*Paper No. 344 of the Journal series of the New Jersey Agricultural Experiment Station, Department of Sewage Disposal.

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faster rate at the inlet end than in the remainder of the flow chamber. This will become clear when one bears in mind the condition of the toilet paper in the flowing sewage.

The figures in the last two columns of the table, from which the curve is constructed, are the calculated percentage increase or decrease of organic matter and of cellulose, taking the figures for the mixture as unity. Thus, in the material from the inlet end the volatile matter and the cellulose is 15% higher than in the mixture. The rate of increase of volatile matter in this compartment is then due to cellulose. This however does not preclude the possibility of other materials settling at a higher rate here than in the rest of the tank. In the middle compartment there took place a 48.8% reduction of cellulose on the basis of the volatile matter, while the volatile matter itself was 9% lower than in the mixture. In the outlet end, the volatile matter had 56.1% less cellulose than in the mixture, while the volatile matter itself was 29% less.

Thus there seems to be a selective settling. Not all the materials settle at the same rate in relation to each other at the different parts of the tank. This would indicate that the deposition of materials in the different parts of an Imhoff tank is different not only quantitatively but also relatively, e.g. in relation to each other. Further, it will be observed that, at least as far as cellulose is concerned, the material from the middle compartment does not represent the average of the conditions prevailing in the tanks, and that the material from the inlet end is closer to the mixture in this respect. This is further indicated by the fact that the curve is not a straight line for cellulose decrease in the successive compartments.

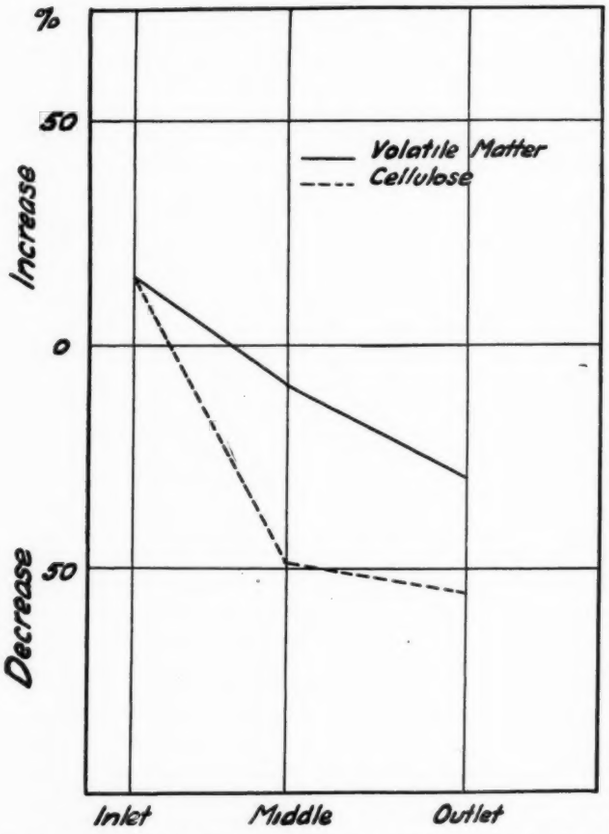

FIG. 1—INCREASE OR DECREASE OF VOLATILE MATTER AND CELLULOSE OVER THE MIXTURE IN THE DIFFERENT COMPARTMENTS OF AN IMHOFF TANK.

Results published previously from this laboratory (3) have shown that the CO_2 content of the gas from the inlet end is higher than that of the middle or the outlet end. In fact, the figure on page 19 of that publication shows that the curves of CO_2 of the middle and outlet end follow each other very closely, while the CO_2 content of the inlet end of the tanks is much higher than the others. This in itself would indicate that the material decomposing at the inlet end is of a different type. Jesse in a paper published in Illinois water survey series (2) as early as 1912 noted that the CO_2 content of the gas from the inlet end of a septic tank was greater. He questioned, however, whether this indicated an early decomposition of cellulose and carbohydrate matter in septic action. He intimated on the other hand that the increased CO_2 content might be due to the long-continued action upon substances accumulated to a great extent in the inlet end.

That cellulose decomposes in the early stages of digestion has been shown elsewhere (1), and that there is actually a greater percentage of cellulose in the inlet end of the tank than in any other part has been demonstrated in this paper. From the coincidence of these two phenomena, namely the greater cellulose concentration of the material and the greater percentage of CO_2 in the gases from the inlet end, it has been suggested that cellulose decomposition increases the percentage of CO_2. As to whether this is actually the case will be demonstrated in a later paper.

The above discussion would indicate that the inlet end of an Imhoff tank is unduly overtaxed while the remainder of the tank is running at less than the efficient capacity. This would make the alternating of the flow of sewage from one end to the other an almost positive necessity.

It is questionable whether, in spite of this, a uniform qualitative and quantitative distribution of solids can be obtained in a long settling tank. May it not be that the advantages cited for deep tanks versus shallow ones of the same capacity may result from this factor of more equal distribution and more efficient utilization of the capacity? It would be another argument for separate sludge digestion provided the material from the settling tanks is properly mixed before it is added to the digestion tank. This would necessitate some kind of a thickener in the settling tank in connection with separate sludge digestion.

SUMMARY

Fresh sewage solids collected from the inlet end of an Imhoff tank have a relatively high cellulose content. The cellulose content is not only higher due to higher solids concentration, but it forms a higher percentage of the solids itself.

A long flow chamber, therefore, affects solids

concentration and the chemical composition of the solids, due to the difference in settleability of the different components. In a tank which is shallow and long there will be an uneven quantitative and qualitative distribution of solids; while if the tank was built for the same capacity but deep, the distribution of solids would be more uniform.

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Special Pumping Arrangement Meets Fire Requirements

Two motor-operated pumps, with a special control arrangement, provide water at low pressure for ordinary consumption, and at high pressure for fire fighting in Jefferson, Texas. Under normal conditions, a comparatively small pump drawing from a flowing well delivers to a water tank, from which the flow is by gravity. Under fire conditions, a high-pressure pump supplies water directly to the mains. The pumps are electrically operated and controlled, General Electric equipment being used. The service pump is of 75 g.p.m. capacity, working against a head of 104 feet, and is driven by a 5-horsepower motor. The motor is controlled by an enclosed magnetic switch, which, in turn, is operated by a pressure governor. A protective float switch automatically shuts down the motor under low water conditions.

The fire pump is of 500 g.p.m. against a head of 220 feet, and is driven by a 50 horsepower motor which is controlled by a push button at the fire station. When a fire alarm is received, an operator at the fire station depresses the push-button, starting the fire pump and closing a gate valve at the foot of the water tank. The fire pump then delivers water directly into the mains at high pressure. When the fire is over, the operation of another push-button stops the fire pump and opens the valve, allowing the service pump to pick up the load.

The Smith and Whitney Company, Dallas, Tex., were the engineers for this system.

Sewage Treatment for North Toronto*

Racks, grit chambers, preliminary sedimentation tanks, activated sludge tanks, separate sludge digestion tanks with provision for controlling the reaction and collecting gases to be burned under steam boilers for heating sludge, and glass housed sludge beds.

By Almon L. Fales†

Some months ago a report on the sewage disposal problem of North Toronto, Canada, was made by Dr. George G. Nasmith of the firm of Gore, Nasmith & Storrie and Harrison P. Eddy of the firm of which the writer is a member. The method of sewage treatment recommended in that report has been adopted, and plans and specifications for the treatment plant are now in preparation. This plant will have a number of rather unusual features and may be of interest to members of the Sanitary Section.

LOCAL CONDITIONS.

District to Be Served. North Toronto is a section of the city of Toronto, covering about 2,700 acres and so situated that an independent sewage treatment plant has been considered advisable. The District is essentially residential and at present only partially developed.

Population. The present population of the District is a little over 25,000 and it is anticipated that this will double in about ten years. It has been estimated that the ultimate population of the District, including outside areas annexed, will be 175,000. It was concluded that the treatment plant to be built at the present time should be designed for a population of 50,000 and so arranged as to permit of enlargement.

Sewer System. The District will be provided with a combined sewer system taking both sewage and storm water run-off, and in addition the flow from certain brooks the dry weather flow of which is estimated at a little over 6,000,000 gallons per day. The main sewer from the District will be 10 ft. 9 in. in diameter, or equivalent section, and will have capacity flowing full, of 1,428 sec. ft. It is estimated that the per capita average dry weather flow of sewage, including brook water, will be 100 Imperial gallons, or 120 U. S. gallons per day. For a population of 50,000 this is equivalent to a daily flow of 6,000,000 gallons.

Character of Sewage. The sewage will be very largely residential and not affected materially by industrial wastes. A study of available information bearing on the composition of the sewage indicates that it will be rather weak.

Stream Flow. The effluent will be discharged into the Don River, which has a total drainage area of about 118 square miles above its mouth and about 100 square miles above the sewage treatment plant site. The river discharges through a channel into Toronto Bay, which is a nearly landlocked body of water connecting with Lake Ontario. The flow in the lower portion of the river is ordinarily quite sluggish. In warm weather there are periods when the flow probably does not exceed that of the ultimate discharge of sewage from the District.

DEGREE OF TREATMENT REQUIRED

In view of the local conditions a high degree of

*Paper before the Sanitary Section, Boston Society of Civil Engineers.

†Of Metcalf & Eddy, Consulting Engineers, Boston, Mass.

purification is required, including not only the efficient removal of suspended solids, but also fairly complete oxidation of the dissolved organic matter in the sewage.

It was concluded that storm flows up to a rate of twice the dry weather flow, or 240 gallons per capita per day, should receive complete treatment. The usual requirement of the Ministry of Health in England is that complete treatment should be afforded up to three times the dry weather flow, but the sewage flow per capita in England is only about one-third of the North Toronto allowance, so that the provision made for North Toronto is about twice that in England. For flows in excess of twice the dry weather flow and up to 36 times the dry weather flow it was recommended that sedimentation be provided in storm-flow standby tanks, according to English practice.

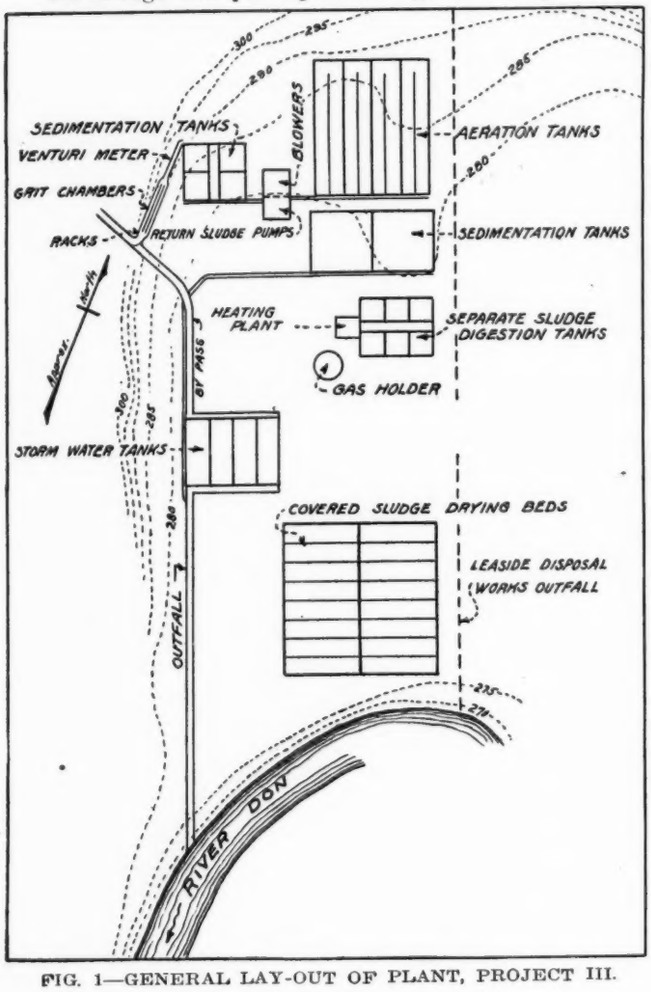


FIG. 1—GENERAL LAY-OUT OF PLANT, PROJECT III.

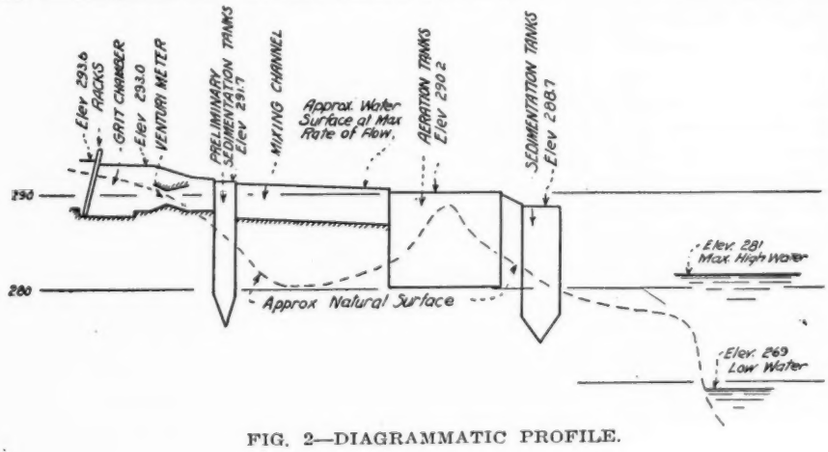


FIG. 2—DIAGRAMMATIC PROFILE.

SEWAGE DISPOSAL SITE.

The site acquired for the sewage disposal plant comprises approximately 109 acres, a large portion of which is relatively low and level land. The location is such that satisfactory isolation is afforded. The elevations will permit of a gravity flow through the plant.

TREATMENT WORKS RECOMMENDED

The plant recommended in addition to storm-water standby tanks, will consist of racks, grit chambers, preliminary sedimentation tanks, activated sludge aeration and sedimentation tanks, covered separate sludge digestion tanks with provision for controlling the reaction of the sludge, and glass-housed sludge beds. The gases from the sludge digestion tanks will be collected and burned under steam boilers, and the steam utilized for maintaining a favorable temperature for sludge digestion and for other purposes.

The preliminary layout and a diagrammatic profile for Project III, which is the one recommended, are shown in Figs. 1 and 2.

Racks. The crude sewage will first pass through racks consisting of parallel bars to remove from the sewage large objects which might cause difficulties in subsequent operation. The relatively small amount of material removed by the racks will be burned, buried or otherwise disposed of in a sanitary manner.

Grit Chambers. After passing through the racks the sewage will flow through one or more of the grit chambers which are in the form of channels, designed to reduce the velocity of flow to about 1 ft. per second, at which rate any sand or similar material in the storm water runoff will be deposited. The material so removed will be used for filling low areas at the sewage disposal site. The object of removing the grit is to prevent subsequent difficulties in handling the sludge and interference with sludge digestion.

Preliminary Sedimentation Tanks. From the grit chambers the sewage will flow to the preliminary sedimentation tanks, of which there will be four units about 15 ft. deep, providing a theoretical detention period of about 1½ hours at average dry weather flow. These tanks will be equipped with apparatus for mechanical removal of the sludge, while the tanks are in service. The sludge will be pumped to separate sludge digestion tanks, which will also receive the excess activated sludge.

The object of the preliminary sedimentation tanks

is to remove the solids likely to cause trouble in the aeration tanks and to lighten the load on the activated sludge plant.

Activated Sludge Aeration Tanks. After passing through the racks and grit chambers the sewage will be mixed with about 25 per cent. of activated sludge from the activated sludge sedimentation tanks and will then pass through the aeration tanks. There will be four aeration tanks about 10 ft. deep, providing a theoretical detention period of about 4 hours at average dry weather flow. These tanks will be of the spiral-flow type, that is, with the air diffuser plates arranged longitudinally along one side of the bottom of each aeration tank, so that the introduction of air sets up a spiral circulation. The ratio of air diffuser area to surface area of tanks will be in the vicinity of 1:10. The allowance for air supply is 1 cu. ft. per gallon of sewage treated.

The air accomplishes the dual object of aeration and agitation of the mixture of sewage and activated sludge. The activated sludge is composed of sewage solids rendered bacterially active by aeration. The presence of oxygen is necessary to maintain the sludge solids in a bacterially active state. The activated sludge, which is in sponge-like masses, absorbs the suspended matters in the sewage and partially oxidizes the organic matter of the liquid portion, rendering it non-putrescible.

Activated Sludge Sedimentation Tanks. From the aeration tanks the mixture of sewage and activated sludge will flow to two activated sludge sedimentation tanks where the sludge will be digested and from which the final effluent will flow to the river. These sedimentation tanks will be between 10 and 15 ft. deep and will afford a detention period of about 2 hours at average dry weather flow. The maximum rate of flow from the sedimentation tanks will not exceed 1,333 gallons per square foot per day. The final effluent will be practically clear, colorless and odorless, and will be stable, as previously stated. The activated sludge treatment will also remove a very large proportion of the bacteria in the sewage.

The sludge accumulating in the activated sludge sedimentation tanks will be removed continuously by mechanical means, the desired amount being added to the influent of the aeration tanks and the excess discharged into the sludge digestion tanks with the sludge from the preliminary sedimentation tanks.

Sludge Digestion Tanks. By the process of bacterial digestion under favorable conditions sewage sludge is rendered inoffensive and may be dewatered readily on sludge beds of porous material. In this process a portion of the organic matter is converted into combustible gas, largely methane. Sludge digestion proceeds rapidly at summer temperatures, but very slowly at the low temperatures of winter, as at Toronto. It is important to prevent acid digestion, which is attended by offensive odors. By controlling the reaction, or pH value, the speed of digestion may be greatly increased. Research by Rudolfs at the New Jersey Sewage Experiment Station, and by Fair and Baity at the Harvard Engineering School, and by others, has shown the great effect of temperature and reaction on sludge digestion, and this has been demonstrated in practice.

There are to be six sludge digestion tanks about 30 ft. deep, providing capacity for two months' storage of the sludge from the preliminary and final sedimentation tanks. The sludge pumped to the digestion tanks will be heated sufficiently to maintain a temperature of at least 70° F. in the sludge digestion tanks. At this temperature sludge digestion will proceed rapidly throughout the year. It is expected that it will be necessary to heat the sludge pumped, to about 90° F. in winter. The tanks will be so constructed as to prevent radiation of heat as far as practicable.

The tanks will be covered and provision made for collecting the gas from sludge digestion, burning it under steam boilers and utilizing the steam so produced for heating the sludge and for other purposes. The collection and burning of the gas will preclude the possibility of offensive odors escaping from the sludge digestion tanks.

Provision will also be made for controlling the reaction, or pH value, of the sludge as pumped to the sludge digestion tanks, by the addition of lime or other suitable alkali.

By the heating and conditioning of the sludge the tank capacity required for digestion will be reduced more than 66 2/3%, or to a sludge storage capacity of about 2 months, as previously stated.

Sludge Beds. Open sludge beds cannot be used in winter in cold climates such as that at Toronto. There would be little or no advantage in maintaining rapid sludge digestion throughout the year, if the sludge had to be stored during the winter. This difficulty has been met by providing for glass-housed sludge beds similar to greenhouse construction.

There will be four glass houses about 40 ft. wide and 168 ft. long, each enclosing four sludge beds about 20 ft. wide and 80 ft. long, The total area of the 16 sludge beds will be approximately 0.6 acre. The sludge beds will be built of sand and gravel or broken stone with underdrains.

The drying of sludge on these beds will not be interfered with by rain or snow, as is the case with open sludge beds. It will be necessary, however, to heat the sludge bed houses in excessively cold weather, to prevent freezing of the sludge. Any gas from sludge digestion in excess of that required for heating the sludge, will be utilized for this purpose.

The sludge on the beds after draining and drying for two or three weeks will be removed, using an industrial track for transportation to the dump. It is estimated that the dewatered sludge will amount to 1.3 cu. yd. per million gallons of sewage treated, which after shrinkage will be equivalent to about 1.4 acre-feet fill per year. This sludge will have some fertilizing value and it is probable that there will be a demand for it in the neighborhood of Toronto.

Storm-Water Standby Tanks. There will be four storm-water standby tanks about 15 ft. deep, providing a storage, or detention period, of 30 minutes when the excess storm flow is six times the average dry weather flow. The standby tanks will

be drawn off and cleaned promptly after each storm. The liquid sludge will be flushed out and pumped back into the incoming sewage and the comparatively clean grit remaining will be removed by mechanical means and disposed of by filling low land at the treatment plant site.

Power Plant. The power required for the operation of the entire treatment plant is estimated to be about 200 h.p., of which 164 h.p. will be required for furnishing the compressed air. The power plant will be electrically operated and will contain blowers of sufficient capacity to provide 1 cu. ft. of free air per gallon of sewage treated, equivalent to 4,200 cu. ft. per minute.

Cost Estimates. The estimated cost of the sewage treatment plant recommended, is $576,000. The annual fixed charges have been estimated at $39,000, based on interest at 5% and uniform sinking fund contributions over a period of 30 years with interest at 4%. The annual operating charges in the immediate future, with a tributary population of 25,000, have been estimated at $28,000.

Use of Vialog on California Highways*

By E. Withycombe†

In the latter part of 1925 the Construction Department began using the vialog during the progress of individual paving projects, to give the resident engineer and the contractor current information as to the smoothness of surface to be expected on the complete job. In carrying out this program, an effort is made to reach each project to make a preliminary record, as soon as a section is opened to traffic. These preliminary tests are followed by subsequent vialog records made during later inspections for the purpose of comparison with the previous work.

The result has been to keep foremost in the mind of the resident engineer, the incentive to develop more effective methods of improving smoothness of pavements. In this effort, it is pleasing to note, they have had the hearty cooperation of contractors.

Several typical projects of both Portland cement concrete and asphaltic concrete, constructed within the last year, have been selected for preparation of charts showing roughness in each half-mile section from the beginning of construction to completion of the project. In each case, an improvement can be noted as the work progresses. A number of factors undoubtedly enter into this improvement but all are more or less influenced by comparisons brought out in the progressive vialog records.

Charts I and II of this compilation give the progressive record of two Portland cement concrete resurfacing projects; Charts III and IV are of two asphaltic concrete resurfacing projects.

Chart I warrants a word of explanation in that the method of finishing was changed after the

* From "California Highways."
†Assistant Engineer, Construction Department.

Vialog (in center of picture) attached to right hand side of automobile dash. Front spring deflections are carried to it by means of a piano wire. Cumulative deflections are recorded on a Veeder counter.

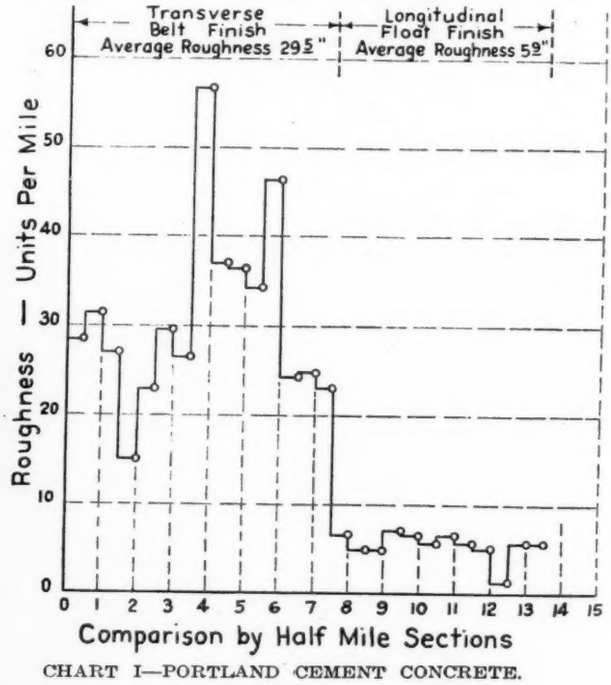


CHART I—PORTLAND CEMENT CONCRETE.

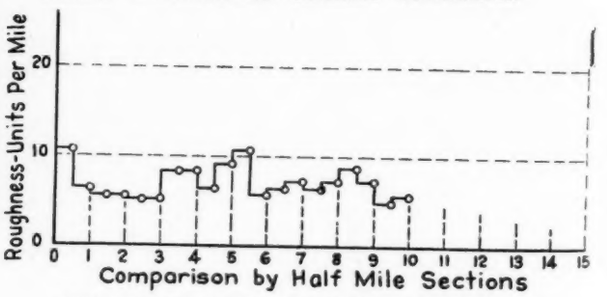


CHART II—PORTLAND CEMENT CONCRETE.

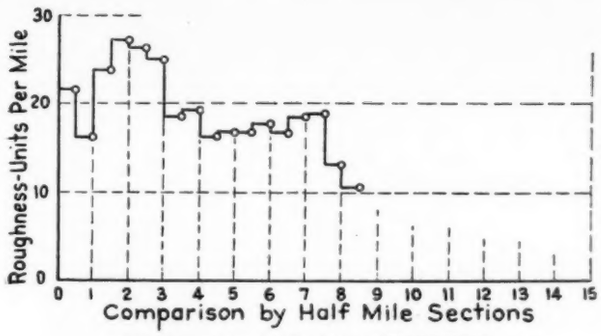


CHART III—ASPHALT CONCRETE

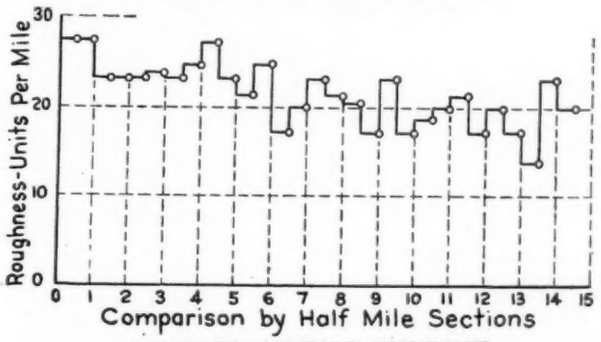


CHART IV—ASPHALT CONCRETE.

completion of the first 7.5 miles. Final finishing of the early part of the work was performed transversely with the canvas belt, while the latter half of the work was given a final finish longitudinally with the light wooden float, as is now common practice.

Due to the length of time necessary for curing Portland cement concrete prior to its opening to traffic, roughness of such pavements can not be detected with the vialog with the dispatch with which records can be made on asphaltic concrete. For this reason necessary corrective measures can not be taken on the cement concrete type as soon as on asphaltic pavements.

The vialog is also utilized to a large extent in comparing methods of handling asphaltic and Portland cement concrete mixtures to determine the resulting smoothness. Likewise, these investigations lead to changes in the mixtures to increase their workability and result in smoother surfaces.

In order to secure records which are comparable with readings on different roads not only in this state but in other states, it is necessary to carefully calibrate the vialog before each test run. Every detail of the operation of the car carrying the vialog must be given attention to secure accurate results. Tires must be inflated to a standard pressure and only tires in uniformly good condition and of uniform resilence are used. The springs are oiled frequently and loading of the car is kept standard for all tests.

Local calibration is effected by running over a section of previously tested road, but standard calibration is obtained by running over a section of road near Sacramento which has been adopted as the standard test road.

Standard roughness is measured by running over boards of standard width at a fixed speed. The state operates two roughness indicators, a vialog and a roughometer which have both been calibrated to the standard readings of the vialog, since that instrument has been in use for a number of years and results so far available are recorded in vialog units.

Efforts are being made by the Materials and Research Laboratory to secure the adoption of standard methods and units in the several states in which these instruments are being used, to the end that a nation-wide comparison of results may be had.

Road Maintenance Equipment*

The selection, use and care of state equipment. Suitability, capacity and cost. Inspection, housing and lubrication.

By W. H. Root†

The discussion of these problems in this paper will be confined to state equipment. The same general principles apply to county or township machinery, but not all of the detailed recommendations are applicable in the smaller units of government.

The selection of maintenance equipment is a twofold problem. (1) The type of equipment must be determined, and (2) the particular make must be chosen. The general maintenance problem of every state is to maintain its state system satisfactorily at a minimum cost. This cardinal principle should always be kept in mind when equipment is being purchased or used. When in the development of your maintenance plans it is apparent that new machinery is needed, you should first make a careful study of the future development of the road upon which the equipment is to be used. Otherwise, you may have very satisfactory results for a year or two, and then find yourself with an expensive white elephant on your hands. You should also be sure that the type selected wil fit in with the other equipment already on hand in that particular maintenance unit. In other words, cooperation of equipment as well as cooperation of men is essential.

SELECTION OF EQUIPMENT

In choosing an equipment type, the most important consideration is that the equipment selected must do the job that you have for it, and that it must continue to do this job over a reasonable period of years. I mean by that that the type must be proven. A particular type machine has not established its right to serious consideration until it has been operated under typical conditions for a year or more. Do not construe from this that the purchase of new designs is undesirable. Every state should buy new developments of machinery adapted to their work, but such purchases should be limited to a few experimental outfits until the machine has proven itself. Personally, I do not look with favor upon so-called demonstrations. I never yet saw a machine fall down on a demonstration. A clever operator and

*Paper before the American Road Builders' Association.
†Maintenance engineer, Iowa State Highway Commission.

a wisely selected road will put over any machine for a few days or weeks.

When you have determined the type of machine best adapted to your work, your problem is only half solved. Whose machine are you going to buy? Don't let the salesman do all the talking. Ask a few questions yourself. Don't allow yourself to be sold by a salesman, but rather be sure you are sold on the machine.

It isn't necessary that you buy the lowest priced machine, but you should be sure that the machine you buy is not overpriced. Some machines are priced for trade-ins. This fact is not hard to determine, and if you find it to be the case, don't pay cash at trade-in prices. You should also look into the matter of parts, prices and service. Any machine will require new parts occasionally, and these should be furnished at a reasonable price, and they must be furnished promptly. Delays due to poor service on repair parts are expensive.

POWER AN IMPORTANT FACTOR

Also look to the power of any equipment you are considering. Horse power ratings are not always reliable and an under-powdered machine is a constant expense and irritation. The fuel cost is another item which should be investigated. It is not enough that the machine do the work required of it, but it should do this work at an economical operating cost.

Then last but not least, in determining the dealer from whom you will make your purchase, keep in mind that it is always desirable to deal with a well established firm. Our junk yards are full of useless orphaned machines. The amount of money represented by this junk is a tremendous sum, and in my mind is one of the few public road expenditures which is open to criticism. In this day of rapidly changing conditions and methods, it is a problem for any machine company to keep its equipment abreast of the times. Machines are continually developing weaknesses, and proving unequal to the constantly increasing tasks to which they are put. These so-called "bugs" require study and adjustment. If when a machine is sold, the seller considers the deal closed, that machine is an undesirable purchase. Be sure the company you deal with is one that takes an interest in its sales, not only until your name is signed on the dotted line, but continuously thereafter through the entire life of the machine.

CARE OF EQUIPMENT

For the purpose of this paper it is not necessary to enter into any extensive discussion of the use of maintenance equipment. This subject in itself might readily be expanded to cover the whole field of road maintenance. In this connection, I simply wish to say that maintenance equipment should be used often and should be used hard. However, it should not be abused. Use a machine for what it is designed plus a reasonable overload. This word "designed" is used advisedly. Some machines are designed to do certain work, while others are manufactured to sell. If you are a good buyer you will not have on hand any machines of the latter class.

All maintenance equipment should be properly cared for. If you will recall how you mothered your first Ford for a month or two after its purchase you will have an idea of how you should treat your road machinery, but this careful attention should not be allowed to lapse as soon as the paint wears off. Road maintenance equipment should be kept painted. This not only preserves the equipment against the weather, but it has a good psychological effect on the operator and upon the public. An operator is less apt to abuse a well painted machine than he is a rusty, weather-beaten one. Also the public will judge you somewhat by the appearance of your equipment. If you keep your machinery painted bright and clean the public will feel that you are endeavoring to conserve the road funds that they have supplied to you. On the other hand, if your equipment appears run down and uncared for, the public may get the impression that, if you are careless in these little matters, you may also be careless in the larger matters of highway finance.

INSPECTION AND HOUSING

All maintenance machinery should be gone over every few days and loose nuts, joints and bearings made tight. Rainy days when the equipment cannot be operated are ideal times for this kind of work. As to the housing of equipment, most machines should be stored inside in order to protect them from the elements and from the light fingered public. Road economists have figured that the depreciation (due to weather) on certain types of equipment is less than the interest and depreciation for housing facilities, and they, therefore, maintain that such equipment should simply be kept painted and stored in the open. Be that as it may, there is still the matter of public psychology to deal with, and for my part, I would prefer to house the equipment rather than be censured for an apparent neglect.

LUBRICATION

Without doubt, the most important consideration in the care of maintenance equipment is lubrication. I do not know of any modern road equipment that does not require some sort of lubrication, and on some of the more complicated types an hour of greasing and oiling each morning is a necessity. If we had perfect lubrication we would have no wear, and barring breakage, theoretically, our machines would last forever. The nearer we come to this ideal, the longer our equipment will last, and the most reasonable will be our maintenance costs.

In conclusion then, I would sum up the paramount points to be considered in selection, use and care of maintenance equipment as follows:

(1) Buy a proven machine from a reliable established dealer.

(2) Use it but do not abuse it.

(3) Keep it lubricated.

Subsoil Difficulties in Seattle

In commenting on subsoil trouble in Seattle, W. H. Tedeman, assistant city engineer of Seattle, Wash., gives the following information regarding experiences in that city:

"About seven years ago we paved a minor thorofare across an area where the subgrade material consisted of a yellow clay which was known to soften when wetted. An attempt was made

to keep the surface drainage away from the subgrade by constructing a tile and gravel drain to intercept such water, but the capillarity of this material is apparently very high. At any rate many corner breaks have occurred since then, proving that our drainage provisions did not suffice.

"The next improvement under similar conditions caused us to accept the prescription of the Bureau of Public Roads of removing about six inches of the subgrade and replacing it with pit-run sand and gravel, where the moisture equivalent determined by actual test their co-efficient of 20. We have not yet experienced any cracks on the job built in this manner, and are quite optimistic that none will occur.

"The sub-grade material in Seattle ranges from solid rock to swamps, the intermediate gap being supplied by almost every conceivable material, and we have now adopted the practice of making the moisture equipment determination whenever there appear such clays as our experience indicates are liable to soften."

Systematic Photographic Records of Public Work

Rhode Island Bridge and Highway Departments find them valuable as records of actual materials and methods used in construction, evidence in damage suits, etc.

David D. Bouchard

Although many State engineering departments and private concerns take pictures in connection with their work under construction, probably none has developed a system of photographic records as complete as that now in use by the bridge department of the Rhode Island State Board of Public Roads.

Filed in the State House in Providence is a detailed history in pictures of every bridge constructed by the department during the last few years. These photographs form a supplementary record to the survey and construction data and have proved valuable for reference work, in settling matters of litigation and as an aid in perfecting new designs.

Generally, photography in connection with construction work is conducted in a haphazard fashion, and the pictures taken are usually confined to a few interesting or unique features. The Rhode Island Bridge Department, however, considers picture taking of vital importance and the same study which marks the drawing of plans also characterizes the preparation of the photographic schedule. Every step is carefully photographed, so that when the job is finished there exists in the files a camera study which is complete, even to the most minute details.

Each resident engineer is equipped with a camera and it is under his supervision that the pictures are taken. Beginning prior to the survey, photos are taken of topographical and geological features. Particular care is exercised to see that every change in the original landscape is accurately recorded. These pictures play a prominent part in deciding claims brought against the State by abutting owners, since the photos provide conclusive evidence of existing conditions before any changes were made.

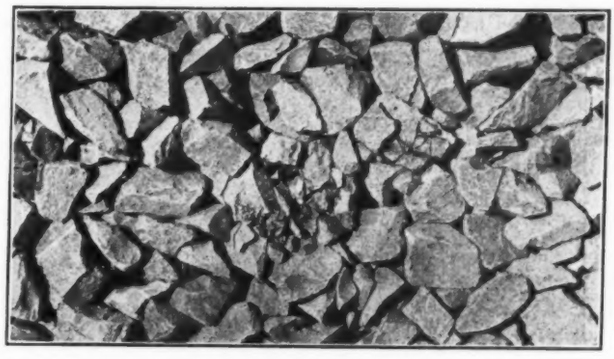
For instance, on one occasion a land owner brought a suit against the State in which he charged that during the process of construction on a certain job, a fence which divided his land was torn down. The case was thrown out when photographs were produced showing that there was no fence on the land in question when the work was begun. In court cases the pictures constitute indisputable evidence.

While the actual construction work is under way, cameras are trained continually on the job. Here they act as State watch dogs. They record truthfully the position of the reinforcement bars. They show clearly the kinds of material used, how the slab spans were placed or the arch rings constructed.

Construction pictures are valuable also for the protection they afford the contractor. If he complies with the plans and specifications the photos will prove it. Later, should the work fail to stand up under its allotted strain, the pictures will go far in exonerating the contractor and will aid materially in placing the blame where it belongs. In settling such disputes, pictures are far superior to blue prints or figures.

The system has worked out so well with the bridge department and the data it supplies are so valuable that the State highway engineers have recently adopted the method in their department. The rudiments of the system used in the bridge department and the one employed by the road builders are identical, with the exception that in bridge construction the matter of photographing details receives more attention. Since it would take yard after yard of film to record each step taken in building a highway, the resident engineer must exercise care and judgement and photograph only the more important developments.

But while step by step photography is rare in road building, the matter of taking pictures of materials used in the job is by no means neglected. At regular intervals pictures are taken. The camera records the kinds of machinery used, the uniformity in



Stones which have broken under pressure of roller give conclusive evidence that the rock delivered was of an inferior grade. Such photographs have proved invaluable as protection against use of inferior materials and in settling disputes between State and contractor.

size of the trap rock delivered and so on through the entire construction work, even to the mixing and pouring of the cement and the leveling of the surface after the road has been laid.

Another difference in bridge and road photography is this. After the road has been completed a camera is focused along the center line of the highway and pictures are taken at distances of every 500 feet. Filed, these give a perspective of the road as it would appear to a person travelling along it in an auto. If curves are to be eliminated in the reconstruction of a highway, particular attention is paid to photographing any changes or deviations from the original layout. Pictorial records are also made of all cuts and fills.

One of the paramount features of the system is the manner in which it facilitates the work of the chief engineer. A daily picture sent to the main office by the resident engineer enables the chief to obtain accurate information as to progress without actually visiting the job. This is a big time saver in a department where as many as 30 jobs are handled at one time.

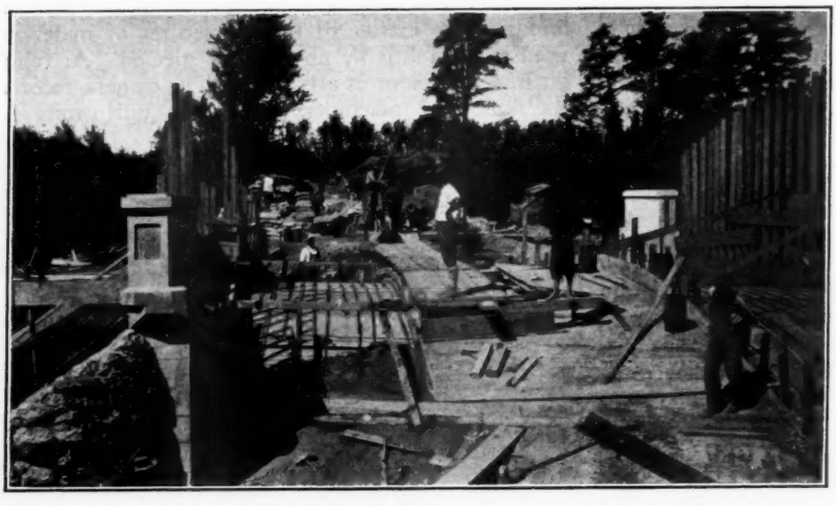
Sitting in his office miles away, the chief can see with his own eyes the job as it actually is, and can estimate progress, detect flaws, if there are any, and ascertain whether the work is done according to specifications. Under ordinary conditions the chief would be forced to wait for the weekly report of the resident engineer. But with the pictures he is kept constantly and adequately informed until the written report arrives.

But the system is more than a record. It is everything that figures are not. It injects personality into the files and preserves facts not obtainable from cold figures. The aesthetic touch, lights and shadows, the silhouette of a bridge against a clear sky, a panoramic view from a highway, are all kept on record through pictures. Camera studies of the beautiful are constantly used in designing and almost invariably pictures from the files can be found on the designers' desk, and are used in preparing new work.

Then, too, there are many intimate and personal incidents which lend individuality to each job that would be lost forever were it not for pictures. Accidents, working conditions, dangers encountered and overcome and other characteristics that leave their mark on every endeavor are perpetuated through the photographic records.

The occasions where these records have proved their worth are innumerable. In one instance they were substituted for an entire set of plans that had been lost, supplying accurately all the information needed.

The record gives a maximum of valuable information for a minimum of cost. And since the pictures are the size of a postal card they can be filed without waste of space.



Photograph typical of information photographs impart to chief engineer absent from the job. Shows clearly the work as it actually was at date—forms in place, position of arch ring reinforcement bars, wing walls, method of construction, etc.

Water Department Accounting Methods*

Important requirements of an adequate Water Department accounting system.

By W. C. Hail†

The object of this paper will be to present, in a general way, what may be considered the more important requirements of an adequate municipal water department accounting system. All forms suggested herein are subject to modification to meet local conditions or to meet the personal ideas of those in charge of the records.

Primarily a water department is interested in its actual cash receipts and expenses, for it is these items that determine the element of profit and loss. It is therefore apparent that the individual customer accounts and other cash transactions should be recorded through separate ledgers.

CUSTOMER'S LEDGER.

The customer's ledger account form ,when properly designed, will carry the following information:

Meter readings by months; amount used; charges; arrears, penalty-discount; amount due; date paid and amount paid. It should also carry the customer's name, address and account number, as well as a meter description (meter number, make, size, and location).

A meter reader reports the readings, usually by routes covering a given district. The meter slips should cover a year period, showing the present and previous month's reading; the customer's name; his ad-

*Paper before Second Annual Meeting, Kansas Water Works Association.

†Senior municipal accountant, League of Kansas Municipalities.

dress and the account number. From this slip the bill is made out on a coupon receipt card. Such cards are then set up in numerical account number order and are posted to the customer's ledger record.

A majority of utilities operating in Kansas require a meter deposit as a guarantee of prompt payment of bills. A subsidiary customer's deposit ledger should be carried, showing on the debit side, the account number, the name and address of depositor, date and amount of deposit received. On the credit side should be shown the date and amount of refund.

Service rendered by the water department to other city departments, such as fire hydrant service, water furnished to flush sewer lines, water supplied for city parks, swimming pools, etc., should be paid for by transfer from proper revenue funds to the utility. Cash receipts from water sales, meter deposits, and their sources should be entered through the ledger accounts suggested, to a distribution cash collection register.

DISTRIBUTION LEDGER.

A well-designed distribution ledger will provide for necessary classifications of receipts and disbursements. The disbursement side should be designed to serve as a warrant register. This ledger may carry any number of account numbers desired. As the volume of business increases there is a general tendency to increase the account numbers, and if this is carried too far, there is danger of swamping the records with details. However, thoroughness and completeness should not be sacrificed in the desire for simplicity. Such classifications of receipts and disbursements should be closed into a general ledger account.

Other ledger accounts necessary for a water department, include: Asset account, liability account, and a reserve for depreciation. These accounts are needed in making up the balance sheet which reflects the true financial condition of the plant.

PRODUCTION DATA.

Production data are important and essential for rate making purposes. The following table is given to show the items used in making up a monthly statement:

The asset account includes:	The liability account includes:
Current Assets	
Cash	Accounts payable
Accounts receivable	Waterworks bonds
Capital Assets	Reserve for depreciation
Real Estate	Reserve for meter deposits
Buildings	
Plant Machinery and Equipment	
Wells, pumps and motors	
Transmisison line	
Reservoirs	
Service line mains	
Meters and meter installations	
Fire hydrants	
Supplies in warehouse	
Other equipment	

The cost of furnishing water may be generally grouped as follows:

General Expense	*Operating Expense*
Salaries of sup't and inspector	Pump and plant wages
Salaries of bookkeepers	Fuel
Printing and office supplies	Oil, waste, packing
Telephone, express, postage	Chemicals
Insurance	Miscellaneous
Miscellaneous	

Distribution and Maintenance	*Capital Outlays and Depreciation*
Wages of outside men	Expansions and extensions
Maintenance of high or low pressure stations	Pumping and purifying plants
Maintenance of distribution system	Mains and hydrants
Maint. and miscel. equipment	Meters and meter supplies
Automobile expense	Lands and buildings
Small tools and repairs	General equipment
	Reserve for depreciation

The importance of frequent reports should not be overlooked. The preparation and distribution of financial reports affords one of the most valuable opportunities connected with the work of an accounting officer. Officials preparing such reports must bear in mind that clearness, brevity and completeness are essential elements.

Production Data and Unit Cost for month of.....

Operating Cost for Month		*Production for Month*
Operation of Pump Plant	$.....	..... Total gals. pumped per master meter
Distribution & Maintenance	.....	..... Sold Consumers
General Expense	.....	..... City Buildings
Bond Interest	.....	..... Parks
Depreciation of Equipment	.....	..... Street Sprinkling
Total	$.....	.... Sewers
		.... Total Accounted for
		..... Water not accounted for
		.... Per cent loss

Cost per Thousand Gals. Computed on Amount of Water Pumped		*Cost per Thousand Gals. Computed on Amount of Water Accounted for*	
Operation	$.....	Operation	$.....
Distribution	.....	Distribution & Maintenance	.....
General	.....	General	.....
Bond Interest	.....	Bond Interest	.....
Depreciation	.....	Depreciation	.....
Total	$.....	Total	$.....

Safety Factors

As a means of reducing accidents, C. D. Buck, Chief Engineer of the State Highway Department of Delaware, recommends that the department have authority to replace hedges at road corners and railroad crossings with open fences; and further, be permitted to arrange for seasonal leasing of field corners at intersections where the owner's rotation of

crops requires those corners to be planted in corn or other vegetation that would dangerously impair the view.

Other recommendations include State control of traffic in towns of six to eight thousand population located on arterial highways; the location of rural mail boxes on the right side of the road, as fixed by the direction of delivery; and the requirement that, in addition to the present punishment, automobile operators convicted of driving when intoxicated to carry for twelve months a new set of marked number plates indicating that fact.

Open Roads for Winter Traffic*

Advantages and practices of snow removal from state highways.

By Professor S. S. Steinberg†

Confined until recently to a few states and to a few main routes, snow removal has now become general practice. A recent comprehensive survey made by the United States Bureau of Public Roads has shown that 36 states find it necessary to remove snow from their rural highways and that last winter 93,000 miles of road were kept clear of snow, an increase of 50 per cent in mileage over the preceding winter.

In order properly to plan a snow-removal program, it is necessary for the highway engineer to make a careful study of snowfall statistics available for his area, as well as other climatic factors which affect snow removal, such as temperature, velocity and direction of the wind, and the distribution, frequency and intensity of storms The records of the United States Weather Bureau are of great value to the engineer in studying snow conditions.

No state in the Union is entirely free of snow. More or less snow falls in all portions of the country with the exception of southern Florida, the lower elevations in southwestern Arizona and southern California. The heaviest snowfall in the United States occurs on the west side of the Sierra Nevada and Cascade Ranges in the States of Washington, Oregon and California, the average annual snowfall in this section being 300 inches or 25 feet. At one place in California, records over a period of years show an average annual snowfall of more than 65 feet. East of the Rocky Mountains, the regions of heaviest snowfall are the Upper Peninsula of Michigan and the Adirondack Mountains in New York, with an average annual snowfall ranging from 10 to 13 feet. In the central section of the Appalachian Mountains, including western Maryland and portions of West Virginia, 7 to 9 feet of snow fall annually on the average.

* Slightly condensed from a recent address from Station WMAL, under auspices of Science Service.

† University of Maryland; Assistant Director, Highway Research Board, National Research Council.

If snow would lie as it falls, little effort would be necessary to remove it from the traveled way and keep highways open the year round for the ever-increasing traffic. In non-mountainous regions, with snow falling rarely to a depth greater than 9 inches for an individual storm, were it to spread uniformly on field and road and remain in that condition, the only equipment necessary for its removal would be the ordinary road grader used in maintenance work or the simply constructed and inexpensive straight blade plow used with high speed trucks. But snowfall is frequently accompanied by high winds which blow the light snow crystals about, and where they encounter obstacles along the edge of the highway to break the wind current, the snow particles are deposited and cause drifts to form on the traveled way. Hedges near the roadway, tight or partially tight fences, standing weeds and other vegetation, and in some cases, plank guard rails often produce drifting on the roadway. Where these obstacles are met at a greater distance from the road, they form beneficial wind barriers by collecting the loose snow and protecting the traveled way from drifts. Among these are field division fences sufficiently far from the roadway and generally parallel to it, tree stumps, shrubs, bushes, standing timber and even corn stalks left uncut during the winter months. Through forest, or shrub or brush country, snow drifting does not occur as the trees and brush break the wind sweep before it reaches the roadbed. In northern Michigan, the state is acquiring rights-of-way 400 feet wide through wooded land. The trees and brush will be left standing when the roads are improved to serve as drift preventives, as well as add scenic beauty to the highway.

To avoid drifting, a study of the road where snow piles up is necessary followed by the removal of all weeds and other vegetation from the confines of the right-of-way. Tight board fences must be removed and replaced with wire fence where fences are necessary, and cable guard rail installed where the plank type is troublesome. As a preventive measure against snow drifting, a number of highway departments in planning new road locations are avoiding shallow cuts in the roadway and where possible elevating the road grade above the surrounding country.

Where the natural features of the road location are such as to make drifting impossible, the state highway departments are erecting permanent or temporary artificial structures, such as snow fences, at a sufficient distance from the roadway to cause the blowing snow to be deposited between the fence and the road. This method of drift prevention is found to be very effective and is widely used. Snow fences are placed 50 to 150 feet away from the road depending upon the topography of the adjacent land. The fence is erected parallel to the road or obliquely but perpendicular to the wind sweep. Generally one line of fence is sufficient but in some cases two are installed. The kind of fence most favored is the woven picket type, four feet high, attached to iron posts. This is found very effective in controlling drifts and the fence may be rolled up and stored during the summer. Last win-

ter more than 1300 miles of snow fence were used by the states located in the snow belt.

In some cases hedges are planted or rows of evergreens are set to the windward side of the road to act as artificial wind barriers with beneficial results. In one county in Michigan, snow blocks are used for the same purpose. It is found that one man can cut the blocks and build one-quarter mile of this fence a day at a cost of from 3 to 5 cents a running foot. As the snow accumulates on the lee side, more blocks are cut and the fence is raised.

Michigan has recently established an experimental station for the sole purpose of finding out all that can be discovered about snow as it may affect the use of the highway. The results of this study will be of great value to all the other states faced with this important problem.

The methods followed and equipment used in the removal of snow are many and varied. They range from the shovel squad to the rotary plow, which, when operated in connection with a caterpillar tractor, finds no drift too deep for removal. The most common types of snow removal equipment in use are the straight blade and the V-shaped plow, each attached to the front of a truck or tractor, the type employed depending upon the amount of snow to be moved. This equipment is used either singly or in tandem formation. During the present season the state highway departments have available for use in snow removal more than 3500 snow plows and 5,000 tractors and trucks.

In some states it is customary to start snow removal operations as soon as the snow has reached a depth of 2 inches and to carry on for the duration of the storm. In other states, this method of attack is impossible as snowfall is too heavy and would blockade the roads soon after clearing and strand the equipment. In such states snow removal is undertaken after the storm has passed.

The cost of snow removal work on the 93,000 miles of roads in the United States cleared last winter by the state highway departments was three and three-quarter million dollars. This is an average cost of $40 per mile, which is a very small outlay considering the many advantages that result from open roads in the winter. A blockaded road causes not only a loss on the highway investment, but is a serious handicap to business and social life. It is necessary that the roads be kept open for wheeled traffic at all times, so that rural mail, school and passenger busses, commercial deliveries, physicians and fire engines may have uninterrupted use of the highway. With snow removal, dwellings are no longer snowed in for the winter, nor do motor vehicles need to be stored for several months of the year.

The expense of snow removal is considered well justified by the saving in spring road maintenance. Studies made in some states demonstrate that the additional gas tax received from motor cars and trucks used during the winter months more than paid the cost of snow removal. An advantage from the standpoint of the highway departments is that with snow removal there is now year-round employment for highway maintenance organizations and equipment.

In Maryland, with an average annual snowfall ranging from 14 inches minimum to 70 inches maximum, it became apparent to the State Roads Commission that highways to render the maximum service to the greatest number of people must be made usable every day in the year. They were not efficient as long as they were only seasonal roads. After considerable experimenting, Maryland found that the great amount of snow and hail that was allowed to remain did much damage to the roads. It was further shown that the cost of removing the snow, at least on the main lines, would be entirely offset by the lessened cost of repairs to the surface in the spring. Therefore, in the winter of 1920-21, five hundred miles of road were kept open and free of snow. This experiment was so successful that during the next winter the snow equipment, including both snow plows and drift fences, was doubled, and has since been steadily increased and improved until during last winter the entire road system of 2,500 miles was kept clear of snow and open to traffic every day.

Paving Questionnaire Returns

Replies to our paving questionnaire were received from 815* cities. Of these 6 were duplicates, making a net of 809 cities replying. Statistics on paving from most of these cities were published in the March issue, but in the case of a few cities replies were received too late for inclusion in the tables.

That the returns are fairly representative is shown by the fact that 20 of the 25 largest cities in the United States responded. The returns by States are as follows: Alabama, 8; Arizona, 3; Arkansas, 12; California, 37; Colorado, 13; Connecticut, 13; Delaware, 1; District of Columbia, 1; Florida, 9; Georgia, 8; Idaho, 6; Illinois, 42; Indiana, 30; Iowa, 23; Kansas, 20; Kentucky, 15; Louisiana, 4; Maine, 8; Maryland, 5; Massachusetts, 27; Michigan, 36; Minnesota, 25; Mississippi, 4; Missouri, 24; Montana, 9; Nebraska, 14; Nevada, 1; New Hampshire, 2; New Jersey, 31; New Mexico, 1; New York, 46; North Carolina, 13; North Dakota, 7; Ohio, 57; Oklahoma, 9; Oregon, 9; Pennsylvania, 75; Rhode, Island 3; South Carolina, 9; South Dakota, 8; Tennessee, 5; Texas, 21; Utah, 5; Vermont, 6; Virginia, 9; Washington, 12; West Virginia, 7; Wisconsin, 35; Wyoming, 4; Canada, 37.

One of the questions asked had to do with the amount of road making equipment in use by these cities. In round numbers, the following items of equipment were reported as being in use by the 809 cities returning the paving questionaire:

Rooter plows, 540; road drags, 1320; road graders, 750; road levelers, 160; scarifiers, 310; steam shovels, 65; dump wagons, 1,545; dump bodies, 436; subgraders, 15; road finishing machines, 35; horsedrawn sprinklers, 1,015; motor sprinklers, 240; motor sweepers, 205; motor flushers, 250; snow plows, 160; snow loaders, 50; tractors, 835; trailers, 250.

Motor trucks, 2,460; derricks or cranes, 65; truck or drag line cranes, 15; portable air compressors, 110; pavement breakers, 90; stone

*Since this was written 41 more replies have been received.

crushers, 110; screening plants, 90; stone unloaders, 10; stone spreaders, 35; gasoline road rollers, 215; steam road rollers, 390; concrete paving mixers, 120; concrete mixers, 440; asphalt kettles, 645; motor-driven oil spreaders, 100; stationary asphalt plants, 50; portable asphalt plants, 25; diaphragm pumps, 475.

Salvaging Pavements in Gary

By W. P. Cottingham*

Fifty-eight percent of the mileage of improved streets in Gary, Indiana, were classified as water-bound macadam or oil top macadam in 1919, when the population of the city was estimated at 50,000. Today, with a population of approximately 100,000 only thirty-one per cent of the entire mileage is of his type of construction. Despite the phenomenal growth of this city, the mileage of such pavements has been reduced during the period quoted from eighty miles to fifty-one miles. During the same time the miles of asphalt surface has increased from 5.64 miles in 1919 to 23.24 miles at the present time. In no single instance has any macadam pavement been removed to make way for a new base for an asphalt surface nor has any asphalt pavement been laid on an entirely new base. In every case the asphalt surface has been applied to salvage the investment previously made in the macadam pavement or in a brick or concrete surface that had reached a point where maintenance was no longer economical.

During the early development in Gary many miles of oil-top slag macadam were constructed on the streets throughout the district controlled by the U. S. Steel Corporation. These pavements served admirably to carry the traffic of the pioneer period but became badly worn by heavy loads combined with the rapid increase in the number and speed of motor vehicles.

In 1914 it was found necessary to develop some means of providing better pavements for some of the streets that were going to pieces. It was determined to attempt an asphalt resurfacing job for one-half mile on the street carrying the greatest burden of automobile traffic. The success of this attempt fully justified the decision five years later to inaugurate a comprehensive program of resurfacing that included practically all the streets of the early development in the original townsite.

*City engineer of Gary, Indiana.

RESURFACED SLAG MACADAM ON SEVENTH AVE., GARY, IND.

The resurfacing program is still being carried on and during the twelve years since the first attempt was made, many types of pavement have been successfully salvaged. Over 300,000 square yards of sheet asphalt have been laid on city contracts over the various kinds of old surfaces at a total improvement cost exceeding one million dollars. Oil-top macadam, water bound macadam, penetration asphalt macadam, brick and concrete pavements have been used as base for the sheet asphalt surface. Streets in the commercial district, in residence districts, and on through route highways have been resurfaced and in every case the result has been satisfactory.

The preparation of the old surface to serve as a foundation course receives careful attention. Known weak spots are removed and replaced with asphaltic concrete binder. Depressions and utility cuts are carefully filled and brought to proper subgrade with binder. Drainage features, curbs and gutters are adjusted to grade and the entire surface thoroughly cleaned. The surface must be rough enough to hold the binder course and prevent creeping or shoving.

When the down-town business streets were resurfaced last year the old concrete pavement surface was roughened by chipping with air hammer drills, thoroughly cleaned with wire brushes and given a paint coat of cut-back asphalt several hours before the first application of binder. A minimum of one and one-half inch of close binder was then laid with the necessary extra binder to bring up the proper cross section contour. A stiff wearing surface one and one-half inches in thickness, finished with a sweeping of cement completed the pavement and permitted the traffic to use the streets with a minimum of interference.

On residence district streets the old macadam surface is disturbed as little as possible and after being thoroughly cleaned and a shoulder prepared against the gutter edge, the binder course is applied to bring up the desired cross section. When the old surface is an oil-top macadam pavement, the entire oil mat is loosened by hand picking to insure its removal. This could be accomplished by spiking with a roller or with a scarifier, but practice has shown that either of these methods results in loosening the old slag base to such an extent that it loses its value as a base and the sandy subsoil works up through it under rerolling.

The cross section used is not an arbitrary curve determined by office calculations but is the best surface section that can be secured by the inspector on the job. A straight edge may be used longitudenally but no template is required for transverse section. A minimum thickness of one inch of binder is required and is included in the price of the pavement. Extra binder is used to shape up the surface and is paid for on the bid price per ton of binder. The surface is one and one-half inches in thickness swept over with cement after final rolling.

The control of mixtures and penetration of asphaltic cement is given especial attention by plant inspectors with field laboratory equipment and complete analytical examination and tests by our asphalt pavement chemist. All material used must be approved by the chemist before being unloaded at the

plant. The daily sampling of mixtures at the plant and on the street, with subsequent chemical analyses of same, serves as a complete record of the work for future reference.

The 1926 program included the resurfacing under city contracts of about 50,000 square yards of old macadam streets at a cost of $150,000, and under county contract the resurfacing of one and three quarter miles of asphalt macadam pavement on a through traffic street connecting the business district to a state road.

The cost to property owners for resurfacing residential streets averages about $4.00 per front foot, for pavements from 27 feet to 30 feet in width. This cost includes all items of the operation, such as readjustment of curbs and drainage features, reshaping and cleaning old surface, extra binder and pavement, and all costs for inspection, advertising and issuance of improvement bonds.

Practically all the work has been done by the Municipal Contracting and Supply Company of Gary, with Isaac Van Trump of Chicago furnishing the chemical inspection. The construction has been in direct charge of O. B. Canaday, assistant city engineer, under the supervision of the writer.

Mosquito Control in Birmingham

Oiling with waste motor oil. Locating local breeding places. Trouble at garbage dumps and sewer outlets. Cost 2½ cents per capita.

A fairly satisfactory degree of mosquito control was attained in Birmingham, Ala., during 1926 at a per capita cost of about 2½ cents. Over approximately 70 per cent of the area of the city, control was almost absolute, while conditions throughout the remainder of the city varied with the weather and other conditions. Contrary to the experience in other cities, the control of natural breeding places, such as creeks, ponds, sloughs and ditches, did not suffice, for garbage dumps, manholes, fire barrels, roof gutters and basements produced tremendous numbers of mosquitoes at times.

Birmingham has an area of some 30,000 acres and a population of about 240,000. The budget for mosquito control was set at $6,000 by the health officer, Dr. J. D. Dowling. Of this amount, $5,483 was spent, not including the salary of the director, who was also engaged on other work.

Plans for the campaign included the use of prison labor on some of the work, the collection and use of wase motor oil for oiling work, and the cooperation of other departments of the city. The last did not materialize very satisfactorily; the use of waste motor oil was successful and economical; and the employment of prisoners resulted in a considerable saving of labor cost, and in a certain tenure of service by the workers, with the ability to develop a squad familiar with the work. Only colored prisoners were used, and these took a real interest in the work, prefering it to remaining in jail, or to work in the street gang.

OILING.

Estimates for the work called for the use of 12,000 gallons of oil for an average year, with a 20 per cent leeway over or under, depending on the weather. There was an unusually wet summer in 1926 and about 14,000 gallons of oil were used. About 17,000 gallons of waste motor oil were collected from garages and filling stations at a cost of 2.8 cents per gallon, as compared to a market price for suitable oil of 10 to 14 cents. The total cost for collecting oil was $426.54, which includes labor, foreman, and truck expense.

Early in the season, as is usually the case, this oil worked very well and had a satisfactory larvacidal effect. Later, as the amount of gasoline diluent decreased with the coming of warm weather, it became less effective. Finally, through experiments by I. F. Givens who was in charge of oiling work, a method of cutting the oil with chemical was discovered, which not only greatly increased the killing ability but, by destroying the surface tension of the water, caused the oil to spread very rapidly. The resulting mixture produced a most satisfactory oil. The costs of chemical for this treatment process was $76.25, making a total cost for about 16,000 gallons of very good oil of $501.79, or about 3 cents per gallon.

Oiling was started early and a schedule covering the entire city was maintained at first at 15-day intervals. Lated this was cut to 10 days because of the frequent rains which washed away the oil. The oiling work was very effective. The per gallon cost of applying oil, which was done exclusively by means of knapsack sprayers, was 19½ cents; the total was about $2,700 or half of the whole cost of the campaign.

At the start of the season two inspectors were detailed to do the work of checking up on industrial plants for rain water barrels and similar possible breeding places. Most of these were found and eliminated, but enough remained, especially in the East Birmingham industrial district, to give some trouble in this area. Another check-up eliminated these fire barrels and also discovered many valve pits, abandoned basements and similar structures, all of which were heavy producers.

In July, two of the garbage dumps located near the center of the city caught fire, and were flooded in an effort to extinguish them. Mosquito production on an enormous scale resulted from this, and, because the mosquitos were able to penetrate the dump and breed in water out of reach of oil, control was difficult. The problem was finally solved by running drains back under the dumps and carrying off the collected water. These dumps produced more mosquitoes than all other sources together.

Another rather prolific source of breeding appeared to be the outlets of storm sewers. At each outlet (most of these do not discharge into any stream, but merely carry off the flow from a limited section) a pool is formed, which provides an excellent place for mosquito production. There was

no record of these outlets in the office of the city engineer, and consequently complaints of mosquito prevalence provided the only means of locating them.

Owing to the rainy season, many basements held water and produced mosquitoes; nearly every house under construction had water in the heater pit or basement. Complaints were the chief factor in locating these conditions, as in the case of house breeding conditions. Due to lack of inspectors, house to house inspections could not be made except in a few localities. Around one negro home, 28 containers producing mosquitoes were found. Junk yards also presented a serious problem and were handled only by the use of rather severe measures in cases where proprietors did not cooperate.

Little ditching was done, as money for this work was not available; a few places that appeared difficult to control with oil, such as spring or seep areas, were ditched out with prison labor early in the summer. The cost on this work was very low.

The transportation used consisted of 2 light Ford trucks. From 2 to 5 inspectors were employed, and from 3 to 8 laborers, some or all of the latter being prisoners. The work was begun April 1, and closed October 1.

Late in the summer, as leaves began to fall and clog the roof gutters, these became quite an important source of breeding on the south side of the city, where the houses are perhaps larger and there are many of the older types of houses. Inspection was the only method of locating and eliminating this source of production.

Anopheline mosquitoes were found only rarely; the prevailing type was the Culex, though late in the season some Stegomyia were found breeding in roof gutters on the south side of town. Psorophora proved a real problem for a short time during the first rainy period, but were brought under control by frequent and heavy oiling. Not only do Psorophora bite ferociously, but they develop very rapidly in rain water pools, reaching maturity under favorable conditions in as little as five or six days.

While the campaign was successful in reducing the number of mosquitos, no work of a permanent nature was accomplished, and results attained tend rather to emphasize the need of planning carefully for the future, eliminating permanently mosquito producing areas, and carrying on the work through a regular budget and with a trained set of workmen. Probably the main value of the work accomplished lay in illustrating and trying some of the means whereby costs could be reduced; but any mosquito control campaign to be successful must be on a permanent basis and employ at least a nucleus of full-time personnel.

Fairly good cooperation of the public was obtained through frequent articles in the daily papers, which, as a rule, cooperated to the fullest extent.

Oiling, transportation, labor and drainage work was under charge of I. F. Givens; inspection was carried on under E. C. Crockett. The direction of the campaign was in charge of W. A. Hardenbergh, director of the Bureau of Sanitary Engineering of the Board of Health, and under the general supervision of Dr. J. D. Dowling, Health Officer.

Airplanes for Mosquito Control

Paris green applied weekly to swampy areas at the rate of one pound per acre found effective against Anopheles but not against other mosquito genera.

The marine barracks at Quantico, Va., are surrounded with mosquito-breeding pools, swamps and bays and mosquitoes and malaria have been fought for ten years past by various methods, chiefly drainage and oil.

These measures reduced the mosquito infestation appreciably but did not eliminate malaria convection on the post. During these years the mosquito pest was excessive from the middle of summer until fall.

The late summer mosquito infestation was largely *Anopheles quadrimaculatus,* which came from the large breeding areas of the bays at the mouths of Quantico and Chopawamsic Creeks. This mosquito production occurred among the flotage composed of heavy mats of dead or dying eel grass (*Vallisneria spiralis*) and spear-leaved water lilies.

In 1926 this mosquito production was controlled by Paris green applied from an airplane. Lieut. F. G. Cowie, United States Marine Corps, engineer officer, of the flying field, was detailed to construct a hopper and equip the plane. He made a hopper of 20-gauge galvanized iron of the following dimensions: 3 feet high by 2 feet wide by 3 feet long, the lower 12 inches sloping to the center of the hopper at an angle of 30°. The hopper was installed forward of the cockpit in a TW-3 airplane. This type of plane has low landing speed, is easily maneuvered, and, of the planes available, was considered the safest to use in low flights over marshes and wooded swamps.

The filler hole, 7½ inches inside diameter, was equipped with a self-locking top. The opening through which the mixture was discharged was 6½ inches inside diameter. This opening was fitted with a sliding door held shut by means of springs and actuated by a cable control that was carried back into the cockpit and terminated in a handle within easy reach of the operator. This handle was mounted on a racket quadrant to permit the degree of opening to be regulated.

An agitator was installed in the center of the hopper. This was equipped with a spiral vane 12 inches above its lower end. At the lower end of the shaft, fins were attached 90° apart. These fins made a wipe fit with the inside of the outlet.

A venturi tube was installed under the fuselage of the plane. Its dimensions were 4 feet 4 inches long by 12 inches high at the mouth—3¾ inches high at narrowest point—by 25 inches wide. The outlet of the hopper opened into the constriction of the venturi tube, the point of greatest air velocity, from which the dust was blown out in an even cloud. Such a tube traveling through the air at a high rate of speed creates a small volume of high velocity at its narrow portion and a partial vacuum at its outlet. The dust under abnormal air movement is well broken up as it enters the partial vacuum.

The average load carried n the dusting flights was about 200 pounds. The average flying speed was 65 miles per hour. The plane with this load answered to the controls nicely.

The first flights were experimental and were conducted over upper Chopawamsic Swamp, which is almost impenetrable by land. Portions of this swamp are heavily wooded, with tangled underbrush of vines and briars; other areas are a mass of matted grass and briars interspersed with dense thickets. It required two hours to walk one mile through this swamp.

Three paths were cut through the swamp and near each path, at 25-foot intervals, were set pans of water containing known numbers of larvæ, and horizontal glass slides to receive the Paris green dust. After each flight, the number of particles of Paris green per square inch on each slide and the larvel mortality were noted. The Paris green was mixed with powdered lime or soapstone in proportions varying from 1:1 to 1:10.

The results are summarized in "Public Health Reports" as follows:

Dusting was effective against *Anopheles* in all types of vegetation, from open marsh to densely wooded swamp. It did not affect other mosquito genera.

The effective quantity of Paris green was found to be one pound per acre.

Hydrated lime and powdered soapstone were used as diluents and each was found to be satisfactory.

With wind velocities of less than 4 miles per hour and flying heights 100 feet or less, a 25 per cent. Paris green mixture was effective.

In winds of greater velocity and with flying heights of over 100 feet a dilution of 50 per cent. was effective.

The slides effectively revealed the distribution and concentration of Paris green. The pans of larvæ, although useful, did not give conclusive evidence of the mortality rate.

Larvæ dipping in natural breeding areas is the most valuable method of determining the minimum lethal dose.

When breeding was continuous and heavy it was necessary to dust at weekly intervals.

The cost of material was $0.724 per acre.

Tests of Highway Guards

The Engineering Department of the University of Illinois has recently conducted tests under the direction of Prof. W. J. Putnam to determine the relative safety and strength of woven wire and wood guards of highways. The tests made in the laboratory, and not under field conditions, disclosed the woven wire guard as having in excess of three times the shock absorbing qualities of a 3 x 12 yellow pine plank on a 10-foot span. While in case of accident the wire guard through several panels will be permanently deformed, the danger of injury to the occupants of the automobile and damage to the car is greatly reduced by its use. From the tests, it was found that the energy of a 4,000-pound automobile moving 40 miles per hour would be absorbed by seventy feet of the type of fence tested, without breaking the fabric, while with heavier cars or higher speeds, more fabric will be called into use with the same results.

Coordination of Sewage Disposal and Water Purification*

Sewage treatment works should be designed with a view to use of stream for water supply, present or future.

By Paul Hansen†

The problem of steam pollution is receiving a vast amount of study and effort at the present time. This is partly the result of the definite realization that sewage polluted streams are undesirable with reference to safe water supplies; but oddly enough the chief pressure appears to be coming from other sources. During the last few years the range of people has been greatly increased by good roads, motor buses, automobiles and generally improved transportation. As a result, streams are used to a greater extent than formerly and certainly the condition of streams as regards sewage pollution is becoming better known. Thus the Izaak Walton League, State Departments of Health and similar bodies have taken a determined stand for relief from objectionable stream pollution. Perhaps the efficient operation of water filtration plants and their demonstrated ability to safe-guard a community against some measure of sewage pollution has tended to soften somewhat the demand for abatement of stream pollution on the basis of safe water supplies or, at any rate, has permitted a situation in which other aspects of stream pollution appear at the present time in somewhat greater relief.

Streams and relatively large bodies of water are available for many uses by man, among which are the following:

POLLUTION FACTORS:

a. Water supply
b. Transportation
c. Fisheries
d. Recreation including boating and bathing
e. Drainage
f. Stock watering
g. Ice supply
h. Condenser water
i. Sewage disposal

Man, however, by concentrating into cities, materially affects the suitability or safety of such uses. Streams as natural drainage channels receive the discharge of the liquid wastes (sewage) of adjacent communities from human beings and industries. This sewage discharges into the river harmful bacteria and a substantial amount of organic matter. We have recently been discussing throughout the country the so-called oxygen balance of streams. This relates to the ability of a stream to assimilate the organic matter without creating a nuisance. The natural land run-off carries with it some organic matter from fields, dead vegetation and the like in addition to the sewage. Nature provides for the

* Paper before Illinois Society of Engineers.
† Of Pearse, Greeley & Hansen, Chicago, Ill.

conversion of this organic matter into mineral and then into fish food. An important element necessary for this conversion is oxygen. The water of the stream and some of its organisms supply the oxygen. So long as the organic matter does not use oxygen faster than it can be supplied by the stream and does not exhaust or nearly exhaust the oxygen, digestion and assimilation proceed naturally and without undue disturbance. Thus the oxygen balance with reference to the organic matter pollution becomes important.

Although the oxygen balance serves as a measure of stream pollution with reference to water purification, the bacteriological pollution also should be given careful consideration. The endurance or life of pathogenic bacteria in a river prior to its use for water supply is important. A number of factors affect these stream characteristics, such as time, temperature, turbulance, ice covering and the like. Of these, time is perhaps the most important.

RANGE OF CONDITIONS.

This country exhibits a wide range of river conditions with reference to sewage disposal and water purification. In some cases, as along the Ohio river, there is very little sewage treatment but the water filteration plants have been able to purify the water, in some cases with the assistance of liquid chlorine, in spite of the relatively heavy pollution load. In other cases, as for example some of the smaller towns in the vicinity of New York City and Newark, N. J., the most complete sewage treatment works are necessary in order to protect water supplies which are purified only by chlorination without filtration. Of particular interest is the situation in northern New Jersey where the available quantity of water is already causing some concern with reference to the actual support of the probable future population. Having in mind such a wide range in stream pollution situations, it appears of interest to state briefly a few typical situations which have come within our practice.

Portsmouth, Ohio: Portsmouth, Ohio, is located on the Ohio river between Pittsburgh and Cincinnati. It has a population of about 40,000 spread along a river frontage of some six miles. The water works intake is located about two miles up-stream of the down-stream city limits. There is a district of some 3,000 people located in the extreme up-stream portion of the city for which it was extremely difficult to build an intercepting sewer discharging below the water works intake. Therefore a sewage treatment plant was built, comprising Imhoff tanks, contact tanks and liquid chlorine apparatus for disinfecting the sewage. This plant was built some years ago with the approval of the State Department of Health. It is operated by the superintendent of the water filtration plant.

North Shore Sanitary District: The North Shore Sanitary District includes the water front of Lake Michigan from Cook County north to the Wisconsin state line, a distance of about 30 miles. Practically all the communities within this district take their water supply from Lake Michigan at distances generally less than one mile from shore. Part of the sewage is drained into the lake. At the various outlets, sewage treatment plants have been built providing for clarification and disinfection of the sewage with liquid chlorine. The plants so far constructed serve relatively small populations at Waukegan, Lake Bluff, Lake Forest and Highland Park. In these plants, in general, space has been provided for more complete treatment should that be desired in the future. Consideration is also being given to more complete treatment for the larger centers of population, comprising the chief sources of sewage pollution in the lake.

Springfield, Illinois: The Springfield Sanitary District has under construction intercepting sewers along the east and west margins of Springfield for collecting the sewage and delivering it to a site north-west of the city for treatment. There is also under consideration a water impounding project including a large lake north-east of the city. The east side interceptor therefore had to be planned with reference to the protection of this lake as a future water supply. All of the Springfield sewers are on the combined plan. It was therefore planned to intercept from the existing combined sewers all sewage up to a rate of 2,125 gallons per capita per 24 hours from the future estimated population and to deliver it to one point for treatment. At this point the first 300 gallons per capita will be pumped to the main sewage treatment plant. The remaining sewage over the above 300 gallons per capita will be discharged into the head waters of the lake some eleven miles above the proposed intake and provision will be made for chlorination should a water supply actually be developed.

Walla Walla, Washington: There is now under design a sewage treatment plant at Walla Walla, Washington comprising settling tanks, sprinkling filters, separate sludge digestion tanks and contact tanks for chlorination. The effluent from this sewage plant will not enter a stream to be used for water supply but it will be used for irrigating truck gardens. While this is not a situation directly relating to water supply, it nevertheless relates to the possible pollution of food supplies.

New York City: Some years ago Samuel Greeley designed a sewage disposal plant for the Board of Water Supply of New York City to treat the sewage of Mt. Kisco before its discharge into one of the reservoirs of the Catskill water supply. This village has a population of about 3,000. The treatment comprises sedimentation, contact filters, sand filters and chlorination. This plant also is operated by the Water Department.

SUMMMARY.

It seems desirable at this time to emphasize again the need for considering stream pollution factors with reference to the water supply problem. In all the varied uses to which streams may be put there is none more important than that of water supply. When sewage treatment works are being projected, the use of the stream for water supply either at present or in the future should be carefully reviewed and the sewage treatment works should be designed with reference to such considerations. Perhaps complete treatment works may not be required until some future time, but considerations of area and head should be covered in the design.

The Carquinez Bridge

Some unusual erection features of a long cantilever bridge in California.

California expects to celebrate on May 21st the opening of a bridge across Carquinez Strait which will replace the ferry boats now used and give a continuous automobile route along the Pacific Coast from Mexico to Canada.

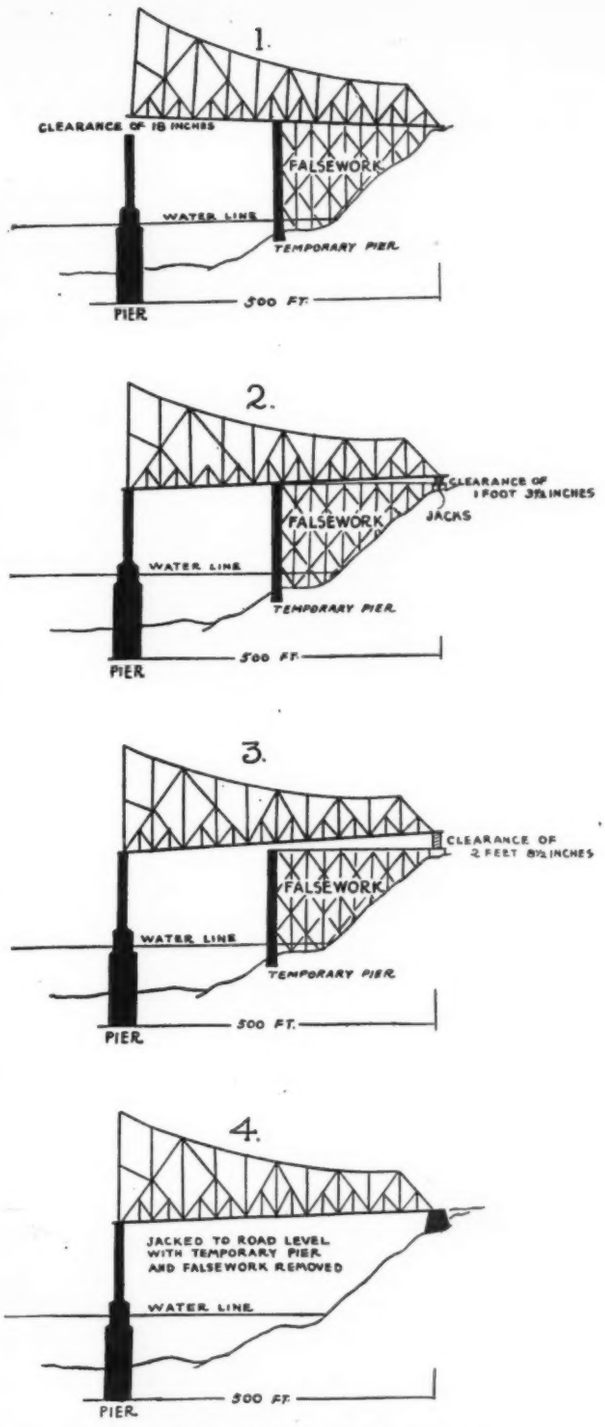
The bridge is a cantilever, with two 1100-foot spans and two 500-foot spans, which, together with a curved approach of 1132 feet, has a total length of 4482 feet, making it one of the four largest highway bridges in America. Each of the 1100-foot spans contains a 430-foot central span suspended from cantilever arms.

Perhaps the most interesting features of the construction were the raising of these suspended spans, and the construction of one of the 500-foot spans where the depth and velocity of the current made false work impracticable.

The water at the first pier at the northern end is 90 feet deep, but for about half the distance from the abutment to the pier the land was above water, or the depth of the water was shallow. The builders decided to erect a temporary pier about half way out between the northern abutment and the first pier, at the edge of the shallow water. This temporary pier cost $80,000. From this pier to the abutment, false work was built and the bridge carried out on this false work to the temporary pier. The steel for the remainder of the span overhung the water, weights being placed on the shore end of the span to balance the greater weight of the overhanging section. When the whole 500 feet had been completed the land end of the span was jacked up 2 feet 8½ inches, lowering the outer end to rest upon the permanent pier and leaving a 3 inch clearance between the bottom of the span and the temporary pier after the span had sagged 6 inches, as calculated. The temporary pier and the false work were then removed.

Another interesting feature of the construction, necessitated by the swift current of Carquinez Strait, was the anchoring in place of the foundation caissons for the four piers by means of six 120-foot steel piles which were jetted down 22 feet into the the mud, the caissons being anchored to the top of the piles by chains until they could be forced down into place on bed rock and filled.

The piers supporting the bridges are of solid concrete 40 feet square and extend 135 feet below water surface. On the piers are built steel towers rising nearly 150 feet to the floor of the bridge. Each of the four steel legs of these towers is approximately four feet square.



CONSTRUCTION OF 500-FOOT SPAN

Distorted scale drawing showing method of erection on falsework and temporary pier and seesawing into place.

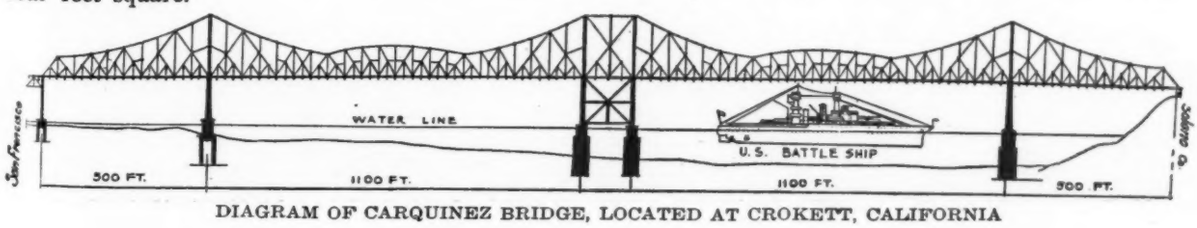


DIAGRAM OF CARQUINEZ BRIDGE, LOCATED AT CROKETT, CALIFORNIA

Connecting the cantilever spans are two suspended spans, which were built in shallow water, floated to a point underneath their position and then hoisted into place. Two steel barges were floated under the span at low tide and a 500-ton jack at each corner transferred the load to the barges, which were towed into the strait and into position. To each corner of the span were then attached two 2½ inch cables, which passed over sheaves on the cantilever arms, while to the other ends of the cables were attached boxes of sand as counterweights, the combined weight of these counterweights exceeding that of the span to be lifted—600 tons. Lifting the first span began at eleven o'clock in the morning and ended at three fifteen in the afternoon, although the actual time of lifting was only fifty minutes. The span was lifted about 133 feet above water level. When in position, 12-inch pins were slipped through the connecting joints.

Another special feature of the bridge is a series of earthquake buffers which hold the structure solid until predetermined earthquake shock amplitude has been reached, when the joints release and allow the structure to act as individual units without impairing its general stability.

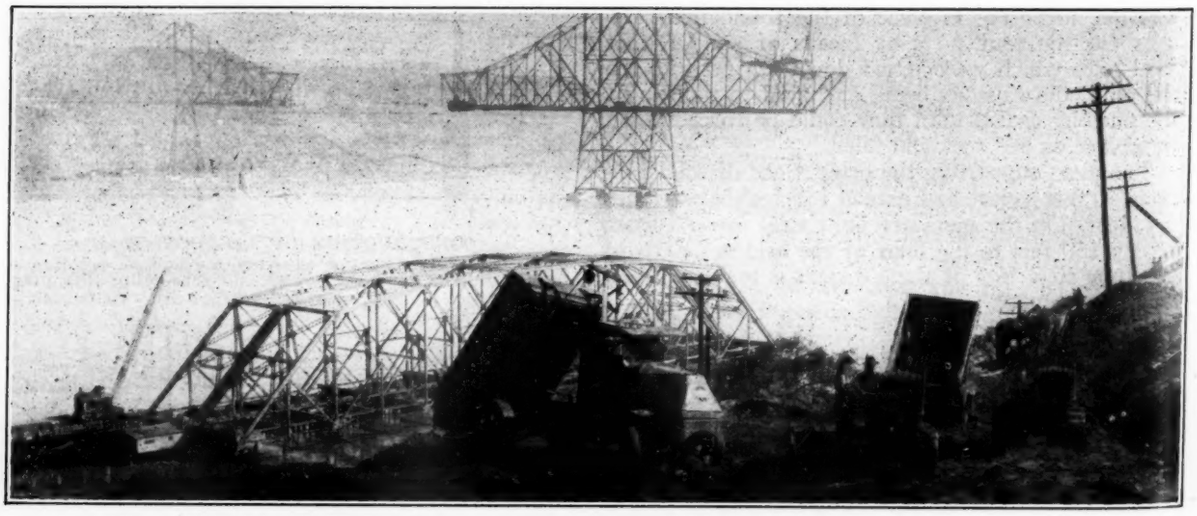
Some of the dimensions of the bridge are as follows: Height of floor above water line, 150 feet. Height of highest truss above the floor, 175 feet. Length of central spans, 1100 feet. Length of end spans, 500 feet. Distance between twin central piers, 150 feet. Length of southern approach, 1132 feet. Diameter of foundation piers, 40 feet. Width of floor, 42 feet, providing 30 feet roadway and two sidewalks. Depth of floor paving, 7 inches. Depth of strait under central piers, 100 feet. Height of concrete piers above water, 8 feet. Height of steel supports for floor, 142 feet. Height of main towers above water, 325 feet.

The bridge was built by the American Toll Bridge Company at a cost of about eight million dollars. The franchise was granted in February, 1923, and the War Department obtained permission in April of that year, 15 days after construction had begun. The foundation contractors are the Duncanson-Harrelson Company and the Missouri Valley Bridge and Iron Company. The steel contractor is the United States Steel Products Company. It is expected that the company will be reimbursed for the cost of the bridge by tolls collected from automobilists. The bridge reverts to the State of California after twenty years.

Another bridge project which is exciting considerable interest in California is that for connecting Oakland and San Francisco. Fifteen different projects and locations for a bridge connecting these cities have been advanced and applications made for franchises. On February 15th the San Francisco Board of Supervisors authorized the Board of Public Works to employ three expert bridge engineers and, in conjunction with the engineers, make a comprehensive study and investigation of the problem of the proper location of terminals, foundations, clearance above waters of the bay, space between piers, loads which the bridge should carry, facilities for traffic at both terminals of bridge, probable conditions of traffic incident to said bridge and the financial problems involved. The large number of interests involved make the proper solution of the problem a difficult one. These include not only the traffic which would use the bridge, but the rights and interest of navigation which must pass under the bridge; the demands of the War Department, especially in connection with the development of the proposed Alameda Naval Base; whether and under what conditions the bridge might be used by railroads and the East Bay Electric Railways, including the feasibility of bringing freight into San Francisco over the bridge; on what basis the toll rates should be established, and so forth.

Michigan Road Maintenance Equipment

During the past two years the Michigan Highway Commission has replaced practically all horse-drawn patrols on trunk line maintenance work with motorized equipment. The one-man tractor-grader and the truck with blade attachment are most favored for this work. These are supplemented at intervals by the use of heavy graders drawn by 10-ton caterpillar tractors, and this heavy equipment has been found very satisfactory for reshaping gravel roads and putting them into good condition to be maintained by lighter equipment.



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Speed and Highway Safety

Recently a questionnaire was sent out by the Pennsylvania Motor Federation asking the views of a number of experts on several traffic questions. One of the questions was in regard to speed of motor vehicles in relation to danger. The replies received were almost unanimous in saying that speed was not the greatest factor in causing highway accidents. Carelessness was considered the greatest single cause of danger. Another question was: "In your opinion, would doubling the width of a 20-foot road decrease the number of accidents?" Most of the answers gave the opinion that wider roads would decrease accidents; R. R. Stoeckel, Motor Vehicle Commissioner of Connecticut, thought that wide roads would decrease accidents only where traffic was classified, and where four lanes of traffic, fast and slow, could be handled.

It appears doubtful if speed itself is the main factor in highway danger; some drivers at fifteen miles an hour are more dangerous than others at fifty. But speed is not a large factor in relief of traffic congestion; neither will wider roads of themselves relieve traffic conditions. Something far more fundamental is needed. The solution of traffic congestion today is in the waterbound macadam stage. Just as that type of road was found unsuited to motor traffic and entirely different methods of construction became necessary, so something far more revolutionary than mere traffic control, widening of streets, or removal of speed limits, will be necessary to secure untroubled motoring over main roads.

Public Health Engineering

A comparatively new field for engineers, and a broad and rapidly growing one, is public health engineering. Health executives are feeling more and more the need for engineering aid in public health matters. In many city health departments, places are being made for engineers; state boards of health are expanding their engineering forces; engineers are finding places in the field of preventive measures in industry and business. As illustrating the last phase, the Cotton Belt railroad, the Alabama Power Co., and the U. S. Steel Corporation employ engineers for this purpose.

Engineers have won recognition in health work, in administration as well as by their technical knowledge, but the number equipped to fill responsible places in this field is entirely inadequate. There is a lack of training facilities. It is true that a number of colleges and universities offer courses in sanitary engineering; in a few schools courses, mostly post-graduate, in various branches of public health engineering are available; but there is no place where a thorough, well-rounded course of training is available.

For that matter, there are no standards by which the men engaged in this work can be evaluated. Few of the state health boards have any fixed requirements with which engineers engaged by them must comply. The Public Health Service, which does maintain high standards, has probably the finest staff of public health engineers now in existence, but the number is very small.

The continuing swift progress in public health work makes more difficult of solution the problem of

training and emphasizes the lack of present facilities. The absence of common standards, the difference in the methods in use by leading health organizations, and the fact that the leaders of these organizations are medically trained men, add to the difficulties.

A real need exists which should be met by action on the part of the leading public health engineers. The fixing of standards, and the providing of facilities for broad and inclusive training and of arrangements for the placing and field training of young engineers are among the first problems.

Causes of Highway Accidents in Delaware

Comprehensive and accurate records are kept of all highway accidents in Delaware occurring outside of Wilmington. A tabulation of these in the annual report of the state highway department covering 600 accidents in which 56 persons were killed and 372 injured, with property damage amounting to $105,-602, shows that 102 were due to carelessness, 42 to inattention, 134 to recklessness, and 52 to driving while under the influence of liquor. Other causes were: Skidding, 37; loss of control of car, 21; passing without proper clearance, 26; glaring headlights, 14; failing to stop at cross-roads, 22; operating while asleep, 14. No accidents are attributed to speeding or to fast driving, but these may be included under the head of recklessness or other items.

Of the 600 accidents, 419 occurred on straight stretches, 131 at intersections, 19 at railroad crossings, 4 at street car crossings, and 27 on curves. Of those killed, 14 were by motor vehicles and 21 at railroad crossings; 16 were pedestrians. Of the 600 accidents, 427 occurred while the highways were dry, 169 while wet, and 4 were due to obstructions.

Scum From Cement

It was found about the middle of last August that water from the public mains used in a Quincy, Mass., bottling plant, when allowed to stand, became covered with a grey, greasy scum. The study of the case was described by Burton G. Philbrick (of Skinner, Sherman & Esselen, Inc.) before the March meeting of the New England Water Works Association. It was found that the water came through recently laid cement-lined pipe and this was believed to be the cause. The scum had an appearance similar to that which collects on water in which cement briquettes are aged before breaking, and microscopical examination easily identified the characteristic crystals of calcium carbonate, which form at the surface and collect dust falling from the air. So far as could be determined, this phenomenon ceased after September.

Mr. Philbrick stated that he could find no reference in engineering literature to similar effects of cement lining, but "personal conversation with several water laboratory men and engineers has revealed that this formation of scum is not uncommon. It has been frequently noted in Rhode Island where the farmers have sunk cement pipes in their wells and on noticing the dirty surface have appealed for advice or information to the state laboratory. Mr. Weston, of the Massachusetts State Department of Health has also given figures obtained from analyses of a Taunton service tap water. This water comes through 475 feet of cement lined main which forms a sort of dead end. The analyses show an increase in hardness from 10 parts per million to 80 parts per million due to flowing through the cement lined main. This is of course an exaggerated effect, but shows clearly the effect of a cement lining."

Ventilation in Trickling Filters*

By A. M. Buswell and A. L. Elder†

The present design of trickling filters is based, to a certain extent, upon theories which have gradually developed simultaneously with advances in sewage disposal processes. The significance of some of these theories is herein reported.

In order to supply sufficient oxygen, filters have been constructed with rather elaborate and expensive bottoms and underdrain systems. Care has been taken in the construction of filters to maintain a depth usually less than ten feet and to avoid the use of fine rock, because of the danger of clogging of the filter as well as the possibility of depleting the oxygen supply.

There are some differences of opinion regarding the supply of oxygen needed for the stabilization of organic matter which takes place during its passage through the trickling filter. Standard text books (1, 2, 3) point out that the supply of oxygen is obtained by the downward movement of air through the filter. According to a report (4) regarding the trickling filters at Austin, Minn., where a specially constructed underdrain is used, there was an *upward* velocity of air in the trickling filter. The velocity of air in the underdrains as determined with an anemometer was about sixty feet per minute.

In view of the studies on the rate of solution of gases (5) and the general knowledge regarding the tendency of gases to maintain uniform composition by rapid diffusion, it seemed unlikely that the rate of biological oxidation in trickling filters was sufficient to deplete seriously the oxygen supply. The report of Wagenhals (6) on Sewage Treatment in the United States does not indicate that different ventilating systems aid materially in sewage purification. He found in his survey of fifteen sewage disposal plants in the United States that at only two plants were any artificial arrangements provided to increase the natural ventilation of the beds and at these there were ventilators with cowls but no noticeable benefit could be noted from them. Some plants had open rubble masonry walls but no special advantage was noted from such construction.

Wagenhals also reported on the types of underdrainage systems used in these plants. The three types used were: "(1) Sloping flat concrete bottoms overlaid with half tile which may or may not be covered with small slabs or plates upon which the stones rest, (2) The bottoms built with channels

*Paper before the New Jersey Sewage Works Association.
†State Water Survey Laboratory, Urbana, Ill.

molded in them, and the channels covered with small slabs, (3) Bottom sloping both ways to a drain in the trough of the slopes. The last is probably the simplest and least costly. It was found only at the Brighton plant at Rochester." At the time of Wagenhals report he found this filter bed operating well, with no indication of clogging, and producing an effluent with a dissolved oxygen content over 50% higher than the five day biochemical oxygen demand. Marston (7) gives a report on the construction of the underdrains at Fitchburg. The type of underdrain used there has appeared to be satisfactory at several plants.

Results of the studies thus far made are herein reported in hope that sufficient interest will be aroused to determine what constitutes, and how best to obtain, an adequate ventilation system at a minimum cost of construction.

Since the report of the investigation at the Austin plant which showed an upward draft of approximately 0.7 miles per hour, a study has been made of the ventilation of the small experimental trickling filters at Urbana, Ill., and also of the trickling filters at the Champaign-Urbana plant. On Jan. 18, 1927 smoke tests were made on the small plant and a positive upward draft was noted in this bed. Since then this observation has been confirmed several times. On Feb. 3, 1927 smoke tests were made at the Champaign-Urbana plant. There was a strong draft downward through the west filter and upward through the east filter. At times of heaviest dosage, the east filter showed little circulation of air in either an upward or downward direction. The temperature of the water going through the filter was 10 degrees C. The air above the filter was 14 degrees C. and the air in the underdrains was 10 degrees C. A strong west wind was probably responsible for the air going down through the west filter and up through the east filter. It appears that the influence of temperature, wind and other factors might be sufficient to completely overbalance any natural downward ventilation secured by the flow of sewage through the bed.

Some theoretical calculations were made to determine the size of the apertures and the velocity of air which would be needed to satisfy the oxygen demand of sewage in going through the filter, and observations were made on filters to determine whether or not there was any oxygen deficiency in the air in either properly operated and well ventilated filters or improperly operated and poorly ventilated filters.

The following method was used in calculating the amount of air needed to supply sufficient oxygen for a filter. Assume a filter of one acre handling one million gallons of sewage per day and removing from the sewage going through the filter 40 p. p. m. of biochemical oxygen demand. Assume that the sewage entering the filter is saturated with oxygen and that the effluent from the trickling filter is also saturated with oxygen. This assumption is true only in cases where the spray is allowed considerable time in contact with the air above the filter. Fuller and McClintock state that sprayed sewage is 60-80% saturated with oxygen. We have found that where the spray never rises more than a foot above the filter it may not be over 40% saturated with

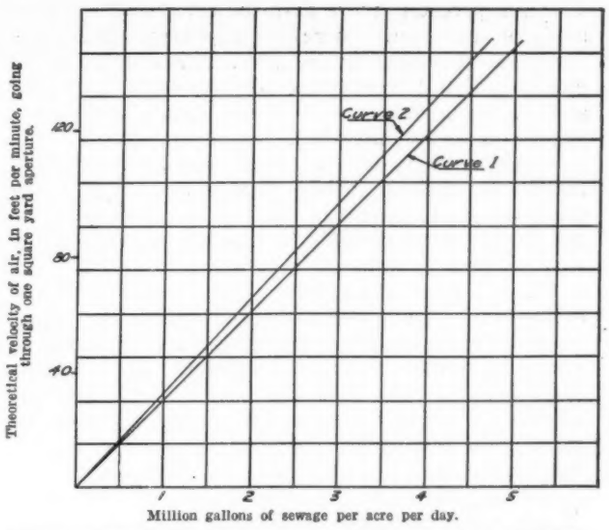

FIG. 1—VELOCITY OF AIR NEEDED TO SATISFY OXYGEN REQUIREMENTS OF TRICKLING FILTERS. To remove 40 p.p.m. B.O.D., assuming 1 per cent. O^2 of the air removed by the process.

Curve 1—No correction made for oxygen needed to saturate liquid with oxygen.

Curve 2.—Correction made, assuming influent 70 per cent. saturated with oxygen and effluent saturated. Dissolved oxygen 8 p.p.m.

oxygen. In well operated filters the effluent is generally nearly saturated with oxygen at the temperature under which the filter is operating. In order to calculate the quantity of air needed for purification we can assume that all the oxygen used in the purification process comes from air passing up through the filter, and that an opening of one square yard per acre is available at all times for ventilation. Figure 1 shows the velocity in linear feet per minute with which the air necessary to remove 40 p. p. m. biochemical oxygen demand would have to pass through the one square yard opening, if the oxygen content of the air was reduced from 20% to 19% by the purification processes taking place in the filter during the passage of the air through it. Curve 1 expresses the results if no correction is made for the air used in saturating the sewage with oxygen, and curve 2 is made assuming 70% saturation of influent and 100% saturation of effluent when the effluent contains 8 p. p. m. of dissolved oxygen. If all the oxygen used in the biological processes in the filter for which the curves were made came from air in upward motion, one notes from Figure 1 that such a filter could handle two million gallons of sewage per day under the conditions specified, lowering the oxygen content of the air from 20% to 19%, and the velocity of the air would need to be approximately only that of the air in the Austin, Minn., plant at the time the report of that plant was made.

No statements were found in the literature which would indicate what might be considered a maximum tolerable deficiency in the oxygen content of the air in filters. Lowering the oxygen content of the air from 20% to 19%, or a loss of 1% was used in making the calculations, because of the ease in making the calculations, using this figure, and the fact that none of the rock filters on which carbon dioxide and oxygen determinations were made showed a loss of that much oxygen. A change of

1% is appreciably more than the error of the determination and would, therefore, represent a real consumption of oxygen in the filter. It is also not to be expected that lowering the oxygen content by this amount would interfere with the metabolism of the organisms in the filter bed.

It was thought that if ventilation of filters was studied by making carbon dioxide and oxygen determinations of the air in the bottom of trickling filters it might be possible to discover when a filter was not getting sufficient aeration.

Table 1 gives the results of the analyses of the quantity of oxygen and carbon dioxide in air drawn from different depths in trickling filters which were operating under different conditions. The Champaign-Urbana filter plant is not overloaded and has available for ventilation and drainage purposes an opening of five square yards per acre. The Downers Grove and Chicago Heights plans were both "ponding" badly at the time the tests were made. Water was standing to a depth of one foot in some places in these two filters. They appeared, therefore, not to have proper drainage systems. No data are at hand for calculations regarding openings for drainage and ventilation at these plants but the fact that water was standing in the bottom of them indicated that they were insufficient. The experimental filter at Urbana is a round tank ten feet in diameter and has openings in the bottom for drainage and ventilation purposes equivalent to 8.3 square yards per acre.

TABLE 1

Quantities of Carbon Dioxide and Oxygen in the Air in Sprinkling Filters.

Date	Plant	Depth of Filter	Depth Sampled	Percent CO_2	Percent O_2
8-10-26	@B	10 feet	9½ feet	trace	19.8
8.24-26	B	10 feet	9½ feet	trace	20.0
8-25-26	B	10 feet	9½ feet	trace	20.0
8-30-26	@C	6 feet	5½ feet	0.2	19.8
8-30-26	C	6 feet	5½ feet	0.2	19.8
8-30-26	C	6 feet	5½ feet	0.2	19.8
8-30-26	C	6 feet	5½ feet	0.2	19.8
8-31-26	@D	6 feet	4 feet	0.4	19.6
8-31-26	D	6 feet	4½ feet	0.4	19.6
8-31-26	D	6 feet	3½ feet	0.4	19.6
8-31-26	D	6 feet	5 feet	0.4	19.6
1-18-27	@A	10 feet	9½ feet	trace	20.0

@ A = Experimental plant; @ B = Champaign-Urbana plant; @ C = Downer Grove plant; @ D = Chicago Heights plant.

The carbon dioxide and oxygen determinations were made with a modified Orsat apparatus. The carbon dioxide was absorbed with potassium hydroxide and the oxygen with alkaline pyrogallate. The determinations made do not have an analytical error of more than ± 0.1%. In view of the work of Russel and Appleyard (8) who found that the composition of soil atmosphere differs little from that of air we breathe, except when the soil is water logged; it seemed highly improbable that any great deficiency in oxygen would be found in the trickling filters. These data are in agreement with their work, and we might expect that as long as the filter was not "ponding" there would probably be sufficient oxygen present even though the filters were constructed deeper and of finer material than is the present custom.

CONCLUSIONS.

It thus appears that ventilation in trickling filters is not always obtained by the downward flow of air through the filters, as is stated in the literature, but can be obtained as well by the upward movement of air through the filter.

Calculations indicate that air may easily be moving with such velocity in trickling filters, that the loss of oxygen in the air, caused by the biochemical oxygen demand of the sewage in its passage through the trickling filter, is within the observational error of the oxygen determination.

Analyses of the air in filters constructed with an adequate drainage system but no special provision for ventilation fail to show a significant depletion of oxygen.

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7. Marston, F. A., Constructing the Fitchburg Sewage Works. Eng. News, Vol. 74, p. 4, 1915.
8. Russel, E. J., and Appleyard, A., The Composition of Soil Atmosphere. Jour. Agr. Sci. *7*, 1-48, 1915; *8*, 385-417, 1917.

Increase in Electric Production

The total annual production of electricity by public-utility power plants in 1926 showed an increase of 11.4 per cent over the output for 1925. Of this quantity about 35 per cent was produced by the use of water power. Electricity produced by the use of fuel increased 9 per cent, and electricity produced by water power increased 16 per cent.

There was a marked improvement in efficiency in the utilization of fuel in the production of electricity by these power plants in 1926. Although the increase in output by the use of fuels was 9 per cent, the increase in fuel consumption was only about 2 per cent. The average rate of consumption of coal in 1926 was 1.95 pounds per kilowatt-hour, showing a gain in efficiency of about 8 per cent during the year.

Handling Heavy Sewer Pipe in Soft Ground

Difficulty was encountered in handing large sewer pipe on construction work at Aspinwall Aviation Field, near Pittsburgh, Pa. Trucks were not able to move in the field because of the soft mud.

An attempt was made at first to haul the pipe by two ropes, one end of each attached to each end of a spreader and the other end to the end of a small pipe that passed through the sewer pipe and was supposed to roll inside of it. This chipped the pipe, and provided no means of holding the sections back while going down hill. Then two wooden crosses were constructed of 4x4's and one placed in either end of the sewer pipe, and a stiff fork was joined to the drawbar, the ends of the fork being connected to the ends of a steel pipe that passed through the crosses. This arrangement solved the problem.

Recent Legal Decisions

RECOVERY FOR EXTRA WORK UNDER CONTRACT FOR SEWAGE DISPOSAL PLANT

In an action for extra work performed under a contract for the construction of a sewage disposal plant, where new plans and specifications were made in the course of the work and a new contract was made to build a plant to conform to the new plans for an additional sum, the Oklahoma Supreme Court held, City of Pawhuska v. Dahlstrom, 243 Pac. 248, that, the second contract being free from ambiguity, it must be allowed to speak for itself, and a recovery for extras furnished under it was authorized without regard to the terms of the prior contract.

Where it did not appear that the contract, when made, was in excess of the current revenues for the fiscal year in which it was made, the burden was held to rest upon the municipality to prove that the debt was illegally contracted by reason of prior appropriations and disbursements.

ADVERTISING ON TRAFFIC REGULATORS HELD NOT SUBJECT TO INJUNCTION BY PRIVATE CITIZEN

The Iowa Supreme Court holds, Tytle Inv. Co. v. Gilman, 206 N. W. 108, that the needs of a city in the matter of municipal improvements are in the discretion, exercised in good faith, of the municipal authorities. Even if advertising on traffic regulators at street intersections constituted a public nuisance, it was held that it could not be enjoined by a private citizen who did not plead and prove special damage, and a statement that it would decrease the rental value of plaintiff's adjoining premises was held purely speculative.

NEITHER VENDOR OF PROPERTY NOR HIS TENANT AFTER DEFAULT OF CONDITIONAL PURCHASE CAN COMPEL DELIVERY OF WATER UNTIL PIPE IS PAID FOR

The purchaser of a house on the installment system got the city to install a water pipe and, after paying $10 of the $70 which the installation cost, defaulted on his purchase. The owner rented the house and the tenant sought to compel the city, which had cut off the water, to resume the service. The Kansas Supreme Court held, Engle v. City of Topeka, 242 Pac. 154, that neither the owner, if he took the property back in the belief the pipe had been paid for, nor his tenant, could require the city to deliver water through the pipe until the cost of installing it had been paid.

CLAIM IN EXCESS OF FUND CREATED TO DEFRAY CONSTRUCTION WORK HELD ILLEGAL

The Oklahoma Supreme Court holds, Dougherty-Nichols Const. Co. v. Town of Jenks, 242 Pac. 167, that a claim against an incorporated town or city for material furnished and services rendered in completion of a sewer and water for the purpose of defraying the expense of constructing such sewer and water system, and which is incurred after the fund has been exhausted, is not a legal liability against the town or city, in view of section 26 of article 10 of the state Constitution and S. L. 1910-11, ch. 80, section 9.

FRANCHISE CONTRACT WITH PUBLIC UTILITY REQUIRING PAYMENT OF PERCENTAGE OF GROSS RECEIPTS HELD VALID

The Oklahoma Supreme Court holds, Huffaker vs. Town of Fairfax, 242 Pac. 254, that the fact an electric light plant is a public utility and under the supervision of the Corporation Commission will not render invalid a franchise contract by a municipality giving the utility the right to install a plant and sell electric current to the municipality and its inhabitants, the holder of the franchise to pay the municipality 1½ per cent. of the gross proceeds of the plant in excess of $5,000 per year, the Corporation Commission not having exercised its paramount power to fix the rates to be charged by the utility.

CREATION BY LANDOWNER OF EASEMENT FOR CITY SEWAGE

The Oklahoma Supreme Court holds, Lamka v. City of El Reno, 242 Pac. 241, that the owner of land adjacent to the bend in a river into which a city discharges its sewage, who changes the course of the river by a cut-off, diverting the flow of the waters from the bend and causing a nuisance for lack of sufficient water to carry off the sewage, cannot receive damages against the city for such nuisance. By his action he impliedly grants an easement for the sewage, and purchasers from him take title subject thereto, and are precluded from receiving damages for the nuisance.

MATERIALMAN'S RIGHT TO SUE ON CONTRACTOR'S BOND ON CITY'S FAILURE TO DO SO

The Georgia Supreme Court holds, Southern Surety Co. v. Dawes, 130 S. E. 577, that the bond of a contractor contracting with a city for the construction of certain public improvements, which makes special reference to the contract and is made payable to "the City of Thomasville or its special attorney," and creates an obligation to "the City of Thomasville * * * and all persons doing work or furnishing skilled labor, tools, machinery, or materials under or for the contract," and in which the conditions are so prescribed in section 1 of Georgia Laws 1916, p. 94, is a sufficient statutory bond under the act; and a materialman furnishing material to the contractor in making the improvements specified in the contract can in his own name, where the city fails to sue in the time prescribed by the act, maintain an action on the bond, although the bond does not expressly state that he may do so.

INCORPORATED VILLAGE CONSISTING ALMOST ENTIRELY OF AGRICULTURAL LAND HELD ILLEGAL

A writ of ouster was ordered by the Minnesota Supreme Court, State v. So-called "Village of Minnewashta," 206 N. W. 455, against a recently incorporated village and its officers, because its area consisted almost exclusively of agricultural land, containing no nucleus of population and not conditioned, as required by the statute, so as to be properly subject to village government. A motion to discharge the writ of quo warranto upon the ground that no public necessity for it appeared was denied. It was held that the mere fact that the law had been violated and an illegal village organized constituted a prime public necessity, and all that was needed, not only to justify, but to require the writ.

CITY HELD JUDGE OF NECESSITY FOR REMOVAL OF HITCHING RACK FROM COUNTY SQUARE UNDER ITS CONTROL

In a suit by a city to restrain county officials from replacing a hitching rack around the courthouse square, which had been removed by the city officials, the Texas Court of Civil Appeals held, City of Lockhart v. Commissioners' Court, 278 S. W. 319, that the act of the county in constructing the curbing, sidewalk and gutter and its tacit relinquishment to the city of control over the thoroughfare, impressed the property, at least while so used, with the character of a public street or thoroughfare. Whether the hitching rack constituted a nuisance or should have been removed from the highway was held to be a question which addressed itself to the sound discretion of the city in the exercise of the sovereign powers delegated to it. Judgment for defendants was therefore reversed for a new trial.

COUNTERCLAIM FOR DELAY IN FURNISHING MATERIALS TO CONTRACTOR HELD INSUFFICIENT

In an action to recover for a quantity of material furnished by the plaintiff to a contractor for a public building, the contractor and the surety on its bond counterclaimed, alleging that plaintiff contracted to furnish materials according to plans and specifications, and schedules for the erection of the building, according to a copy furnished plaintiff, who delayed delivery, thus delaying the construction of the building. The Minnesota Supreme Court held, Jamestown Metal Desk Co. v. Louis Fleisher Co., 206 N. W. 445, that, there being no averment that plaintiff agreed to furnish these materials within any given time or in any given order, or knew when they would be needed, or that they could not be obtained in the open market, or when they were in fact furnished, the counterclaim failed to state any ground for recovery against plaintiff.

FURNISHERS OF LUMBER FOR TEMPORARY BUILDINGS AND RENTERS OF RAILWAY EQUIPMENT HELD ENTITLED TO SHARE OF FUND RETAINED BY STATE HIGHWAY COMMISSION

The Indiana Appellate Court, United States Fidelity & Guaranty Co. v. Macksville Gravel Co., 150 N. E. 390, holds that materialmen who furnished lumber used in erecting storage buildings and quarters for the employees of a state road contractor and those who rented locomotives, trucks, boxes, railway track and switches used by the contractor in the construction of the road, were entitled to a pro rata share with other creditors of the fund retained by the State Highway Commission until the road was accepted, as against the contention that the claims were not within the terms of the contractor's surety bond, because by the labor and machinery furnished to and by the contractor, the claimants helped to create the fund. The court found no similar case among the authorities.

FINANCING BY CITY OF ELEVATION OF RAILROAD TRACKS HELD UNAUTHORIZED AID TO RAILWAY COMPANY

A railway company being financially unable to comply with a city ordinance requiring it to elevate its tracks, an ordinance provided that the city should bear the cost of the work in the first instance, the funds to be provided by the issue of bonds by the city, and that bonds of the company be deposited with the city as security. The Illinois Supreme Court held, Murphy v. Dever, 320 Ill. 186, that the second ordinance contemplated a loan to the railway company, in direct violation of the State Commission, and that the ordinance was void, notwithstanding that the elimination of grade crossings is a proper exercise of the police power.

RENTAL OF CONCRETE MIXER AND OTHER MACHINERY USED IN ROAD CONSTRUCTION HELD NOT WITHIN CONTRACTOR'S BOND

The Ohio Supreme Court holds, Royal Indemnity Co. v. Day & Meddock Co., 150 N. E. 426, that the surety on the statutory bond executed by a contractor for the construction of a public building is not obligated to pay the rental contracted to be paid by the contractor for the use of a concrete mixer, hoisting engine, or other machinery used in doing the work. The statutes intend that the surety shall be liable for such labor and material furnished for the construction of a public building as would be the subject of a lien under the Ohio Mechanic's Lien Law were the building privately owned.

PAVING CONTRACT AWARD HELD VALID

The New Jersey Supreme Court holds, Critchfield v. Mayor and Aldermen of Jersey City, 132 Atl. 321, that the award of a paving contract was not invalidated (1) because the meeting to consider the bids was called and the bids tendered 10 minutes after the time specified in the notice; (2) because the successful bidder had no paving plant, and no satisfactory reasons were given for preparation of cement elsewhere, and this was not permitted in writing by the engineer. This was an obligation to be fulfilled in the performance of the contract; (3) because the ordinance did not fix the rate of interest, where it fixed it at not exceeding 6 per cent., the statutory limit. A bidder who was not a resident or taxpayer of the city could not, in any event, contest the award, unless his bid would have entitled him to the award.

NEWS OF THE SOCIETIES

April 12-13—AMERICAN WATERWORKS ASS'N, FLORIDA SECTION. Second meeting at Hollywood, Fla.

April 20-22—AMERICAN SOCIETY OF CIVIL ENGINEERS. Spring meeting at Asheville, N. C.

April 26-28—SOUTHEASTERN WATER AND LIGHT ASS'N. Convention at Jackson, Miss.

May 2-4—NATIONAL CONFERENCE ON CITY PLANNING. Annual conference at Washington, D. C.

May 9-12—NATIONAL FIRE PROTECTION ASSOCIATION. Annual meeting at Chicago, Ill.

May 12-13—LEAGUE OF TEXAS MUNICIPALITIES. Annual convention at San Angelo, Texas.

May 26-28—TOWN PLANNING INSTITUTE OF CANADA. Annual meeting at Vancouver, B. C.

June 6-8—AMERICAN ASSOCIATION OF ENGINEERS. Annual convention at Tulsa, Okla.

June 6-10 — NATIONAL ELECTRIC LIGHT ASSOCIATION. Annual convention and exhibition at Atlantic City, N. J.

June 6-11 — AMERICAN WATER WORKS ASSOCIATION. 47th annual convention at Chicago, Ill.

June 13—CANADIAN PUBLIC HEALTH ASSOCIATION. Annual meeting at Toronto, Can.

June 20-24—AMERICAN SOCIETY FOR TESTING MATERIALS. Annual meeting at French Lick, Ind.

June 27-30—SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. Annual meeting at Oreno, Me.

Aug. 16-19—INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Annual convention at Salt Lake City, Utah.

September—CITY MANAGERS ASSOCIATION. Fourteenth annual convention, Dubuque, Ia.

Nov. 14-18—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Thirty-third annual convention at Dallas, Tex.

CENTRAL STATES SAFETY CONGRESS.

The first annual Central States Safety Congress will be held in Kansas City, Mo., April 13-15. Governors Baker and Paulen of Missouri and Kansas, both of which states have been active in organized accident prevention work are scheduled to speak at the opening session. Other speakers will include Mayor Albert I. Beach, of Kansas City, one of the few large municipalities to reduce its traffic fatalities last year; Walter G. King, president of the National Safety Council; Col. A. B. Barber, director of the National Conference on Street and Highway Safety; Frank Miller, and Leslie Sorenson.

NATIONAL HIGHWAY TRAFFIC ASSOCIATION.

The annual meeting of the association will be held April 15 at the Automobile Club of America, New York, at which time committee reports in a large number of subjects will be received.

AMERICAN CHEMICAL SOCIETY.

The program of the spring meeting of the American Chemical Society to be held in Richmond, Va., April 11 to 16, will include in a symposium on lime, a discussion of the problem of the treatment and disposal of industrial wastes. Health authorities throughout the country have had enacted laws prohibiting the pollution of streams and state and federal officials are more and more actively enforcing these laws. Practically all industrial plants have effluents and sludges which must be disposed of and few are so fortunately situated as to be able to discharge these into streams without treatment.

In many sections, the problem has become quite acute and extensive efforts are being made to devise methods for the treatment of the various effluents. The investigations include tests of treatments for wastes from steel mills, coke and gas plants,, dye and textile mills, tanneries, creameries, and canneries. In many instances the problems involved have included preservation of fish life in the streams as well as protection of the water supplies and the elimination of nuisances along the waterways.

The Boards of Health of many of the states are cooperating with their industries, and in a number of these states associations of the local manufacturers in the individual lines are undertaking cooperative investigations. In Wisconsin a very extensive series of tests, looking toward the disposal of cannery wastes, were conducted during the past year by the State Board of Health, in conjunction with the Wisconsin Canners' Association. In this case, a lime and iron treatment proved most satisfactory.

These tests, among others, will be described by L. F. Warrick, of the Wisconsin Board of Health, and other sanitary engineers and chemists will participate in the discussion. C. P. Hoover will discuss water purification and softening.

NATIONAL FIRE PROTECTION ASSOCIATION.

The following nominations have been made by the nominating committee to be voted on at the annual meeting scheduled for May 9-12, at Chicago: President, Dana Pierce, Chicago, Ill.; first vice-president, Allen M. Schoen, Atlanta, Ga.; second vice-president, Frank C. Jordan, Indianapolis, Ind.; secretary-treasurer, Franklin H. Wentworth, Boston, Mass.; chairman executive committee, Albert T. Bell, Atlantic City, N. J.

AMERICAN WATERWORKS ASSOCIATION

The nominating committee of the American Waterworks Association has selected the following to be voted on at the Chicago meeting to be held during the week of June 6: President, James E. Gibson, manager and engineer, Water Department, Charleston, S. C.; vice-president, William W. Brush, chief engineer, Department of Water Supply, Gas and Electricity, New York; treasurer, George C. Gensheimer, secretary, Commissioners of Water Works, Erie, Pa.; trustees, S. M. Van Loan, deputy chief, Bureau of Water, Philadelphia; L. R. Howson, Alvord, Burdick and Howson, Chicago, Ill.; Geo. W. Pracy, superintendent, Spring Valley Water Co., San Francisco, Calif.

AMERICAN ASSOCIATION OF ENGINEERS

The next annual convention of the American Association of Engineers will be held at Tulsa, Oklahoma, June 6-8, 1927, in conjunction with the annual meeting of the Oklahoma Divsion, A. A. E.

MISSOURI PURIFICATION CONFERENCE

The second annual Missouri conference on water purification was held on November 19th and 20th at Jefferson City, Mo. The chairman was A. V. Graf, chemical engineer of the St. Louis Water Department. Among the papers read were: "Elimination of Algae Tastes and Odors in Water Supplies," by W. F. Monfort; "Selling an Appreciation of Good Water to the Consumer," by Dr. A. C. Magill; "Hydrogen Ion Control of the Purification of Mississippi Water," by E. E. Wolfe; "Maintenance and Operation of Sewage Disposal Plants," by C. A. Haskins; "Assuring Satisfactory Water by Control Methods," by Dr. G. F. Gilkison; "The Mechanical Clarifier as an Aid in Water Treatment," by Frank Bachmann; "Value of Beautifying Waterworks Plants," by R. E. McDonnell; "Operation of Coagulation Basin," by A. V. Graf; "Iodine Content of Representative Municipal Water Supplies," by Dr. W. T. Schrenk. There were also round table discussions on filter plant equipment and maintenance; filtration; chlorination; feeding chemicals; iron removal and softening; laboratory control; daily operating records, and efficient operation of old equipment.

PERSONAL

Frederick A. Davis has been appointed engineer for the City Plan Commission of New Haven, Conn.

James M. Fourmy has been appointed state highway engineer of Louisiana, a position which he held two years ago.

Thomas L. Watkins, formerly assistant to Frank R. Lanagan, former deputy state engineer, has been appointed state engineer of New York State.

E. E. Terrell has been appointed county highway engineer of Hennepin county, Minnesota.

M. H. Brondson, commissioner of public works of Providence, R. I., and before that, city engineer of that city, died Jan. 15.

W. Chester Morse has been appointed city engineer of Seattle, Wash.

Col. Woolsey Ferinell, recently appointed Commissioner of the Alabama State Highway Department, has appointed William Toxey, formerly engineer of Tuscaloosa county, and George L. Moulton, also of Tuscaloosa, as assistant engineers to the director.

George H. Ferguson has been appointed Chief Sanitary Engineer for the Provinces of Quebec and Ontario by the Caadian Department of Health.

R. A. Thompson, Dallas, Tex., Consulting Engineer, has been appointed engineer of the Texas Etate Highway Commission. Mr. Thompson has had extensive engineering experience in various lines of work.

Russell S. Greenman has resigned as Senior Assistant Engineer, office of the State Engineer of New ork, and has opened an office in Albany for the practice of concrete engineering, with laboratory facilities for testing and inspection.

R. Platt Boyd, a former State Highway Commissioner of Alabama, has been elected secretary of the Alabama branch, Associated General Contractors.

CIVIL SERVICE EXAMINATIONS

Assistant scientific aid, Junior scientific aid, Under Laboratory apprentice: Applications received to April 30, 1927. To fill vacancies in the Department Service, including the Bureau of Standards. Entrance salaries $1,500, $1,320, and $1,140 per year respectively. Advancement after six months' probationary period depends upon individual efficiency. increased usefulness, and occurrence of vacancies. For position of assistant scientific aid, examinations will be held in the following optional subjects: Advanced general physics, ceramics, chemical engineering, civil, mechanical and electrical engineering, paper technology, physical metallurgy, physics and chemistry, and textile technology. For other positions, registers will be established in physics, chemistry, and in the combined subjects. Assembled examination about ten days after closure of receipt of applications.

PROFESSIONAL ENGINEERS IN FEDERAL EMPLOY

The United States Civil Service Commission has just issued a pamphlet describing the work of engineers in the Federal executive civil service, of which more than 3,000 are civilian professional engineers. Nearly 700 civilian engineers are employed in the various divisions of the War Department, 600 in the Department of the Interior, 600 in the Department of Commerce, 450 in the Department of Agriculture, 350 in the Navy Department, 250 in the Treasury Department, and 200 by the Interstate Commission. These engineers are employed in practically every branch of endeavor to which engineering is applied, including road building, construction of lighthouses and public buildings, conservation of national resources, research and testing, cadastral surveying, topographic work, irrigation, aeronautics, sanitation, waterways, building ships, etc. Many of these offer engineers unique training and experience not to be duplicated in private industry. Also they come in contact with men of national and even international reputation whose collective interests cover the entire field of engineering. As a result, many engineers in Federal service have found a government position a stepping stone to a more highly remunerative one in private industry.

The salaries of the lower grade begin in most cases at $1,800 a year, while promotion may lead to maximum salaries of $3,000 in the Forest Service, $7,500 in the Bureau of Public Roads, Bureau of Light Houses, or Bureau of Reclamation; or to $6,000 in the Coast and Geodetic Survey, the General Land Office, the Geological Survey, Indian Affairs, Navy Department, Bureau of Public Health Service or War Department; or to $5,000 in the Patent Office, Bureau of Standards, National Park Service, Coast Guard, Bureau of Internal Revenue or Quartermaster Corps.

MUNICIPAL AND OTHER PUBLIC REPORTS

North Jersey District Water Supply Commission. Report July 1, 1925 to June 30, 1926. Resume of work, including description of work at the Wanaque project. Ill. 98 pages.

Water Board of New Bedford, Mass. Report for year ending Dec. 31, 1926. 64 pages.

Village of Oberlin, O. Report for year 1926. Ill. 32 pages.

Lucas County, O. Report on construction and maintenance of county highways for 1926. Ill. 32 pages.

Water Resources of California. Summary report and coordinate plan for development. By Paul Bailey, State Engineer. Ill. 49 pages.

State Highway Commission of Oregon. Biennial report for two-year period ending Nov. 30, 1926. Ill. 587 pages.

State Highway Department of Delaware. Report for 1926. Ill., 73 pages.

Highway Department, Newport, R. I. Annual report for 1926. 43 pages.

Department of Highways of Nevada. Fifth biennial report for 1925-1926. Ill., 21 pages. Nevada Laws Relating to Highways, Motor Vehicles, Gasoline Tax, etc., 1925. 56 pages.

State Highway Commission of Missouri. Fifth biennial report for period ending Dec. 1, 1926. Ill., 366 pages.

Department of Highways, Province of Nova Scotia. Ninth report, 1926. Ill., 256 pages.

TRADE PUBLICATIONS

Curing Concrete Roads with Solvay Calcium Chloride. The Solvay Process Co., Syracuse, N. Y., 32 pp. Ill. A booklet designed to present to the contractor and highway engineer the latest information on the use of calcium chloride as a curing agent for the construction of concrete roads. The section headings which give a very good idea of the contents are as follows: Economy of Concrete Roads; Methods of Curing; Surface Method; Integral Method; Repairing Broken Sections; Curing on Grades; Scaling; Wear; Cantilever Method of Testing; Curing at Low Temperatures; Quick Hardening Concrete; 96-Hour Curing; Portland Cement Association Test; Transverse Crack Reports; Packages, Service and Shipment.

Expansion Joints. Servicised Products Corporation. Chicago, Ill. 40 pp. Ill. Describes in detail the various joints available for use in concrete road construction. Gives specifications for transverse and longitudinal joints, both premoulded and poured, and for sewer pipe joints. Devotes some space to consideration of sewer pipe jointing with bituminous materials.

The Activated Sludge Process of Sewage Treatment. The General Filtration Company, Rochester, N. Y. 88 pp. Ill. This valuable booklet describes the activated sludge process in a chapter which is abstracted from "Sewerage and Sewage Disposal," by Metcalf and Eddy, and follows this with a brief discussion of aeration, re-aeration, and sedimentation tanks. In the next nine chapters are given descriptions of some of the most important activated sludge plants in the country. Most of these descriptions are reprinted, or abstracted, from articles appearing in various of the technical magazines; many of them have been reviewed and brought up to date by the original authors. Chapters XII to XIV are given over to the subject of diffuser plates. Chapter XV gives tabular data on plant design and operation. The three final chapters discuss in some detail the value of activated sludge as a fertilizer, and methods of disposal of excess sludge.

Modern Practice in Tank Protection; Pipe Protection. Hier, Hubbell and Co., San Francisco, Calif. 18 sheets, each. Ill. The booklet on tank protection states the principles of the painting of iron and steel, including preparation of surface, priming coats, and film thickness. Specifications are giving for painting acid, brine, and oil storage tanks, water tanks, concrete tanks, and tank cars. Pipe Protection gives specifications and directions for coating large pipes by both brush and dip painting with oil and pigment paints.

In addition, corrosion and methods of preventing it are discussed and specifications are given for the painting of the outside surface of penstocks.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

INGERSOLL-RAND PORTABLE COMPRESSOR-PUMP OUTFIT

The Ingersoll-Rand Company, 11 Broadway, New York, has announced a new combined portable air compressor and water pump outfit. It consists of a standard Type Twenty Gasoline-Engine-Driven Portable Compressor and a Cameron Air-Driven Pump. It is particularly designed for dewatering jobs, but can be used for the elevation of water, for removing the overnight accumulation in ditches and excavations, for cement gun service, for furnishing water to concrete mixers, and similar jobs. The portable compressor, in addition to supplying air for the pump, will run such air tools as "Jackhammer" rock drills, paving breakers, clay diggers, portable hoists, and drill steel sharpeners.

This new outfit, it is stated, fills a long-standing demand for a truly portable pump that can be moved easily from place to place as needed. The pump is positive in action, requires no priming, and will handle very muddy water. It can also be regulated to any desired capacity within its maximum rating by adjusting the amount of air admitted.

Most jobs now require compressed air and a compressor is, therefore, generally available. The advantage of having an air-driven pump mounted on the compressor is at once apparent, as this arrangement eliminates the gas or oil engine formerly necessary to drive the pump. With this outfit, the pump is ready for work whenever the compressor starts up. The unit can easily be moved from place to place as occasion demands.

Several sizes of these compressor-pump outfits are available. It is also possible to obtain the pump alone, together with all parts necessary for attaching it to any Ingersoll-Rand Portable now in the field.

UNIVERSAL TRENCH HOE

The Universal Crane Company, Cleveland, Ohio, has developed a ⅝-yd. trench hoe attachment for Universal cranes. This attachment is designed to increase further the all-round application of Universal cranes to handle the harder digging jobs on which full efficiency is not reached with the clamshell or dragline buckets.

Three major parts make up this attachment. A 19-foot boom, a dipper arm and an auxiliary A-frame member which is designed to take the stresses and strains of trench hoe operation. The attachment is adaptable to use with any Universal with double drums separately driven. It is readily and quickly transferable with the standard crane boom for use with clamshell or dragline bucket, hook, block, backfiller board, etc.

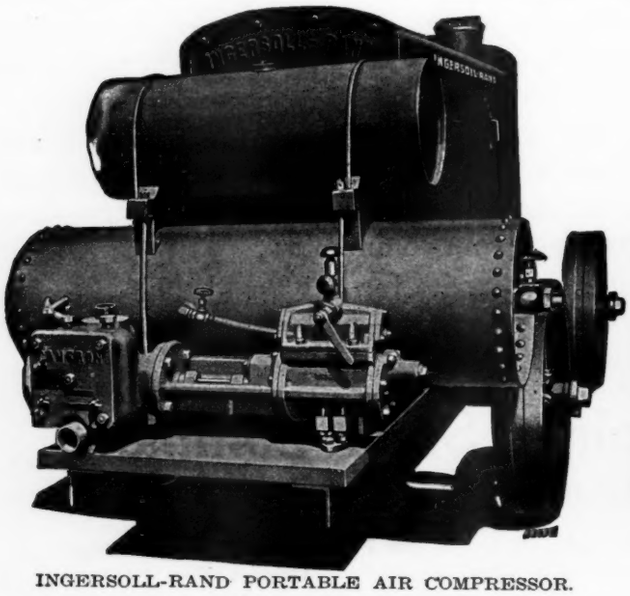
The working radius of this attachment is 26 feet, with a digging depth of approximately 13 feet. These are obtained with the crane mounted on a standard 5-ton motor truck. Great care in the design of this attachment has been exercised to develop strength and sturdiness and yet keep the weight down to permit stability with the truck mounting. This has been achieved so well, it is claimed, that with the trench hoe working at the maximum radius the unit possesses the same stability as with the standard 24-foot crane boom and ½-yard clamshell bucket.

An exclusive feature of this attachment is the automatic tilt bucket for dumping materials direct into trucks. The ⅝-yard bucket is hinged at the front end and arranged to pivot about this point for spilling materials. Material is taken in and dropped through the front open end of the bucket.

UNIVERSAL TRENCH HOE

NOVO "FLUD-OIL-D" PUMPS

The Novo Engine Co., Lansing, Mich., has announced their new "Flud-Oil-D" enclosed, self-oiling, one-, two-, and three—cylinder pumps. The new Novo Single Cylinder enclosed piston pump, is double acting, inside-packed, and powered with Novo one-and two-cylinder gasoline engines or electric motors. All working parts—gears, pinions, crossheads, and bearings—are automatically lubricated and run in a bath of oil. The two-cylinder is a larger version of the one-cylinder. The triplex pump is designed particularly for road builders, being of the proper size to operate with a 28-E paver. The capacity is 70 gpm at 500 pounds pressure. It is powered with a Novo NF, 25 h. p. four cylinder engine and is mounted on a steel truck. The pumping plants with all gears, pinions, crossheads, pins, and bearings enclosed in an oil-tight case, are automatically lubricated. The pumps have no grease cups.



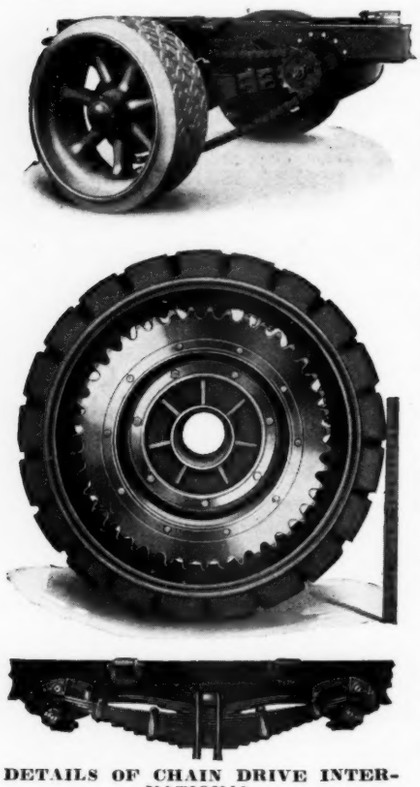
INGERSOLL-RAND PORTABLE AIR COMPRESSOR.

NOVO "FLUID-OIL-D" PUMP.

NEW CHAIN DRIVE INTERNATIONALS

The International Harvester Co., Chicago, Ill., has added two new types of four-cylinder dump trucks with nominal ratings of 2½ tons and 3½ tons respectively to its already very complete line of trucks. The smaller of these, designated as Model 54-C, has a capacity of from 2½ to 3 yards, and the larger, designated as Model 74-C, 4 to 5 yards.

The chain-drive truck appeals to many because of the simplicity of the chain mechanism, the ease with which adjustments and repairs can be made while the truck is on the job, and also the ability of the truck to pull out of gravel pits and excavations. Both models are provided with a wide range of gear ratios so that when necessary a maximum of power can be exerted in pulling up steep grades and at other times a fair rate of speed with a minimum of fuel consumption can be attained on level and easy-going stretches. The transmission includes four speeds forward and one reverse. In the larger Model 74-C truck, in addition to the reduction gear type of drive, the live axle has a two-speed range, which provides an exceptionally wide choice of power applications.



DETAILS OF CHAIN DRIVE INTERNATIONAL

A very simple arrangement for adjusting the tension of the chains is incorporated in the steel radius arm, which transmits the torque from the rear wheels to the frame. Adjustment is made so easy thereby that liability of neglect of chains is greatly reduced and hence danger of undue wear on chains and sprockets resulting from the chains running too tight or too loose is considerably lessened.

Removable cylinders; worm and wheel steering gear with post carrying wheel at a 30-degree angle and connecting shaft vertical, thus giving maximum foot clearance, comfort and convenience for the driver; and auxiliary rear springs that go into action after the load reaches a certain amount, thereby providing additional cushioning effect when loads are heavy, are features which have been retained in the new chain-drive models. The frame consists of deep double steel channels, one inside the other, each section being ¼-inch thick, and a liberal number of cross members that give the entire chassis great rigidity.

HELTZEL MYSTERY BIN

The Heltzel Steel Form and Iron Co., Warren, Ohio, has brought out the Heltzel "Mystery Bin." The bin, in general, consists of 80-and 105-ton bins cut squarely in the middle on a perpendicular line, each half having its own trailer wheels. The principal idea of this type of bin construction is to avoid the difficult handling and erection of larger capacity bins. In erecting, temporary legs are fastened to one of the halves and it is stood upright with a crane. The other half is then lifted with a crane and the two halves securely fastened together with 40 bolts. The temporary legs are then removed and the outfit is ready for use. When in trailing position, each truck is no larger than a standard 35-ton trailer bin and can be hauled by truck through congested street traffic at usual speeds of 10 or more miles per hour. The agrabatchers, which are supplied for measuring materials either by weight or volume, are also revolutionary in construction. One man, located on a Trilok self-cleaning, steel grating platform, performs the complete operation by turning a wheel control, meanwhile being able to observe that all conditions are right for dumping. Weighing and measuring agrabatchers are interchangeable using the same frame and bolt holes. In the weighing equipment, it is not necessary to level the scale, since a modified beam type scale is used with two-point suspension and equalizer. In the measuring equipment, the turning of a single wheel control performs the complete operation of filling, cutting off, dumping the batch of sand and stone, opening the upper gates, and closing the lower gates in less than ten seconds.

THE LINN TRACTOR

The Linn Mfg. Corp., Morris, N. Y., manufactures a tractor for heavy hauling of the track laying type, which is similar to a heavy truck in design, control and upkeep and therefore offers the advantage that an ordinarily intelligent automobile man can operate and maintain it without special training. The outstanding features of the traction member are great flexibility of rear drive; a mechanism which automatically compensates for unevenness in the ground; the machine so supported that no weight is carried on any axle; and the use of 12 per cent. manganese steel in every part subject to abrasive wear. A compensating device contributes to the flexibility of the track by permitting it to take up freely on uneven surfaces, maintaining proper track tension and taking up wear automatically. Should rocks or ice pack or catch between the sprockets and the tracks, a compensating mechanism permits the sprockets to slip one tooth, forcibly ejecting the obstruction. The weight of the machine travels over the hubs of large spool rollers, the flanges of which in turn travel along the track.

The transmission provides four forward speeds, with a maximum speed of eight miles an hour under ordinary conditions with a 100 horse power tractor. By means of an automatic lubricating device, once every mile, regardless of speed, each of the eight bearing surfaces has a definite supply of fresh oil forced to it. The tractor has a draw bar pull of 15,000 pounds at 1½ miles per hour to 3,000 pounds at 8½ miles per hour. The motor is a Waukesha model 6 AL, three point suspension, 4½ inch bore and 5¾ inch stroke, rated at 100 horse power.

LOCKING MANHOLE COVERS

Brown & Brown, Inc., Lima, O., manufacture manhole covers provided with a locking device which is automatic in operation, making it possible to replace the lid without use of a key if desired. The key is provided with a handle which permits using it to lift the lid as well as to unlock it. The cover is positively guaranteed by the maker against rattling in service. The ornamentation on the top of the cover is changed to suit any particular city or sewer district.

The company also makes an adjustable manhole cover, which can be lowered to adjust it to a wearing pavement, or raised or lowered to allow for a change in grade when a pavement is relaid or resurfaced.

REINTJES FLEXIBLE ARCH TILE

Geo. P. Reintjes Co., Kansas City, Mo., manufactures a flexible arch tile, which it is claimed, forms its own arch, requiring no temporary arch centers or skewbacks. Only two shapes of tile are needed, regardless of the thickness of walls, or width of span, nor is leveling needed, as the units remain level with adjacent brickwork without any leveling medium. Each step is equal to a brick course, and the arch is built up in sections the width of one brick course. The tapered key is claimed to facilitate repairs, allowing replacement arches to be driven to a tight fit without disturbing overhead brickwork. Any interior section of the arch can be repaired without interference with the remaining sections.

REINTJES DOUBLE STEPPED ARCH

Link-Belt Sludge Collectors at Gastonia Operated Five Years Without Repair

RUNNING continuously for more than five years without cost of maintenance other than that for oil and grease, is the unusual record of the Link-Belt Sludge Collectors in the final settling tanks of the Activated Sludge Plant at Gastonia, N. C.

When machinery operates unfailingly over such a long period of time, something more than the inherent quality of the materials used, is responsible for such a record — *it must be designed right.*

Put your next problem up to experienced Link-Belt engineers.

3060

LINK-BELT COMPANY

Leading Manufacturers of Elevating, Conveying, and Power Transmission Chains and Machinery

CHICAGO, 300 W. Pershing Road — INDIANAPOLIS, 200 S. Belmont Ave. — PHILADELPHIA, 2045 Hunting Park Ave.

Atlanta - - - - - 511 Haas-Howell Bldg.
Birmingham, Ala. - 229 Brown-Marx Bldg.
Boston - - - - - - 1103-4 Statler Bldg.
Buffalo - - - - - - 554 Ellicott Square
Cleveland - - - - 527 Rockefeller Bldg.
Denver - - - - - - - 520 Boston Bldg.
Detroit - - - - - - 5938 Linsdale Ave.
Huntington, W. Va.- Robson-Prichard Bldg.
Kansas City, Mo., R. 436, 1002 Baltimore Ave.
Louisville, Ky. - - - - 349 Starks Bldg.
New Orleans - 504 New Orleans Bank Bldg.
New York - - - - 2676 Woolworth Bldg.
Pittsburgh - - - - - - 335 Fifth Ave.
St. Louis - - - - - - - 3638 Olive St.
Wilkes-Barre - 826 Second Nat'l Bank Bldg.

H. W. CALDWELL & SON CO.:—Chicago, Western Ave., 17th and 18th Sts.; Dallas, Texas, 1221 Mercantile Bank Bldg.; New York, 2676 Woolworth Bldg.
LINK-BELT MEESE & GOTTFRIED CO.:—San Francisco, 19th and Harrison Sts.; Los Angeles, 361-369 S. Anderson St.; Seattle, 820 First Ave., S. Portland, Ore., 67 Front St.; Oakland, Calif., 526 Third St.
In Canada—LINK-BELT LIMITED—Toronto and Montreal.

LINK-BELT

Sewage Disposal Plant Equipment

STEEL PAVING GUARDS

The W. S. Godwin Co., Inc., Baltimore, Md., manufacture steel paving guards for road edging and widening, expansion joints, transverse headers, concrete curbs, platforms and steps, and for general paving and railway use. In addition to complete protection of edges and joints, construction with paving guards is claimed to be cheaper than other types of construction yielding less satisfactory results. Godwin steel paving guards, used for road edging work, consist of a heavy steel guard, cast into the paving base and held there against traffic shocks, by means of 7-inch anchors spaced every 10 inches. This strengthens the edge by distributing the stress and strain of traffic over a larger area of the base, and, by acting as a retaining wall, forms a rigid side support for the surfacing material, preventing chipping, flowing and mashing. Advantages claimed for their use in road widening are the assurance of maximum usable road width, and the reduction in the cost of preparing the old edge for contact with the new pavement. In paving along street railways, the Godwin guard is stated to be of especial value as preventing pavement deterioration by track movement, since it allows for free rail movements without effect on the paving, there being no connection between the paving structure and the rail.

SULLIVAN DIAMOND DRILLS

The Sullivan Machinery Co., Chicago, Ill., has just announced two new types of Sullivan Diamond Core drills. The Sullivan heavy duty, mounted type, diamond core drill, Class "N," is driven by a direct-connected Buda Engine and mounted on a heavy truck with wide steel wheels for transportation in rough country. This machine, while it was designed particularly for deep structure testing in the oil fields, is also adaptable for a considerable range of mineral prospecting and engineering test boring work. Its portability and the absence of a boiler with the fuel required make it a compact rig and one easily moved from place to place in difficult country, where supplies are hard to haul. The "N" mounted rig has a capacity of 2000 feet in depth and removes a 2-inch core. The hydraulic cylinder is of a new heavy duty pattern and the drive rod is arranged to permit the use of large size fittings for fish tailing or mud bit work. The new "Turbinair" diamond core drill is a hard metal prospecting or test boring machine with a rated capacity of 800 feet in depth, removing 15/16-inch core. It may be mounted on either surface frame or on columns for use under ground. Sullivan screw feed with friction escapement is provided similar to that employed on the Sullivan "Beauty" diamond drill. The motor is the well known "Turbinair" motor used in Sullivan portable hoists, coal cutters etc. This motor will run on steam if desired. An electric motor may be substituted if the machine is to run on electric current.

SULLIVAN DIAMOND CORE DRILL.

CHAUSSE OIL ASPHALT REPAIR PLANT

The Chausse Oil Burner Co., Elkhart, Ind., makes a portable asphalt repair plant developed to meet the demand for a unit, readily transportable and capable of producing economically material for street repairing which is equivalent to the mixtures delivered from large stationary plants. It produces hot asphalt and is claimed to be the first fully complete, portable, moderate-priced unit for doing the entire patching of medium-sized and small cities, for localizing patch work of large cities, for supplementing stationary plants and for winter patching when large plants cannot be run economically.

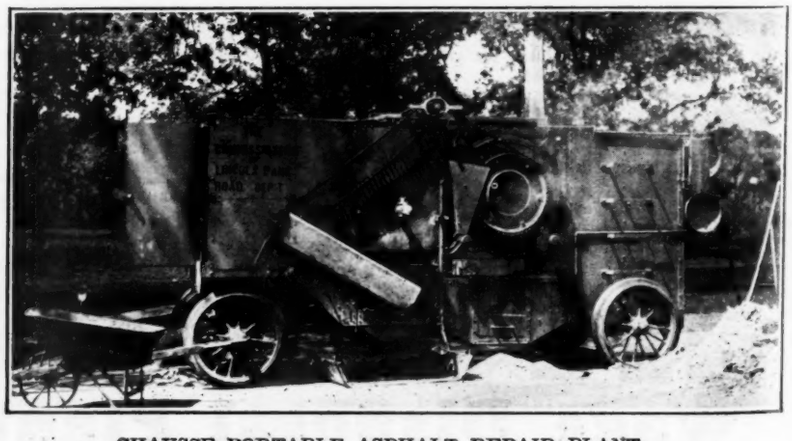
The new Model E-3 plant is a mechanically operated machine with rotary sand drier, pug mill mixer, oil burners and measuring devices. In addition, are features of self-propulsion on rubber-tired wheels and storage bins for material, which make this machine an independent unit for use directly where repair work is being done.

It is claimed that in actual service these plants can keep five men busy raking and laying, but that the operating cost is low, requiring for operation only two men, four gallons of kerosene per hour and ten gallons of gasoline per day. The Model E-3 plant is equipped with Continental Red Seal four-cylinder engine which drives the rotary sand drier and pug mixer and furnishes power for propulsion.

The rated capacity of the Model E-3 Chausse plant is 150 square yards of 2″ compacted mixed per eight-hour day, but it will operate economically on a very small output or produce a considerably increased amount. In fact, this machine, it is claimed, will produce a 450-lb. batch, sufficient to cover 2 1-3 square yards with 2″ compacted asphalt every five to six minutes. It will handle any desired mixture from mastic to asphaltic concrete and maintain the formula uniformly.

A tool heater, with oil burner, is located at the rear of the machine for heating rakes, tampers, shovels and smoothing irons.

In the machine are bin storage for 135 gallons of asphalt 2¼ cubic yards of mineral aggregate, 18 bags or 1750 pounds of lime dust or cement, and tanks to hold 60 gallons of kerosene and 9 gallons of gasoline. The weight of the machine with tanks and bins empty is 9400 lbs.



CHAUSSE PORTABLE ASPHALT REPAIR PLANT.

SUMTER SUPER-SIPHON

The Sanitation Corporation, New York, has just put out the Sumter Super-Siphon. This siphon is designed for flushing sewers and for dosing. For the former work it is installed inside the tank; in dosing service, installation is outside the tank. It consists of a siphon which discharges through an S-trap into a plugged tee at the end of the sewer, with the addition of two pipe loops, one of which, the air loop, connects the uptake of the siphon with the air chamber of the S-trap, while the other, the water loop, connects the downtake of the siphon with the air chamber also. It is the addition of these two small pipes which makes the apparatus distinctive.

In operation, the air loop allows air to be expelled from the siphon into the air chamber of the S-trap until the water reaches the level of its connection to the uptake. After that the air loop is sealed and the trapped air in the siphon is compressed between the rising column

A—Times Square
B—New Madison Square Garden
C—Polyclinic Hospital
D—DeWitt Clinton Park
E—Furness-Bermuda Line, Lloyd Sabaudo Line
F—Swedish American Line, Navigazione Generale, Italian Line
G—St. Elizabeth Hospital
H—Sheffield Farms Co., Main Office and Milk Distribution Station
I—Knapp Memorial Eye Hospital
J—DeWitt Clinton High School
K—Sloane Hospital for Women
L—Roosevelt Hospital
M—Broadway
N—Columbus Circle
O—Central Park

of water in the uptake and the surface of the water in the trap. Continued rise of water level creates sufficient pressure in the trapped air to blow the water out of the water loop and let the trapped air escape to the air chamber and through to the sewer. This escape of the air is of course immediately followed by the discharge of the water through the siphon. Discharge goes on until the water level in the tank falls below the top of the sewer. At this point, air from the sewer comes up through the air loop and breaks the flow of water. This breaking is gradual, and insures that at the end of each flushing discharge, the S-strap and the water loop shall be full of water, instead of being emptied into the sewer, and the water seal for the next filling is automatically established.

NEW HARNISCHFEGER BACKFILLER

The Harnischfeger Corporation, Milwaukee, Wis., announces a new, improved type of backfiller. The construction of this new model is consistent with that of their new line of all-steel excavators, being built on a foundation of unit cast steel construction. All shafting is in the same plane, thus making it a simple matter to renew any shaft or gear. The lever arrangement has been simplified to four levers instead of seven, as has been the usual custom heretofore.

The boom hoist and swinging is power controlled through worm and worm gear. The boom can be swung through 180 degrees. The hoist speed is 300 f.p.m. while the dragline speed is 150 f.p.m. As a clamshell it handles a ¼-yd. bucket. The lifting capacity at 15 feet is 2,000 lbs. The hoist line fairlead is adjustable and consists of five ball bearinged rollers of large diameter which are used for crane and clamshell work as well as for backfilling work. Each drum is provided with an independent foot brake. The scraper is unusually sturdy, being pressed from heavy plate metal. The angle of the scraper plate and also the pulling chain is adjustable to take care of the various soil conditions.

The boom is of lattice type and is adjustable from 22 feet to 30 feet in steps of 18 inches. Steering brakes are foolproof and can be locked positively. A sheet metal canopy over operator and machine and another over engine are provided as standard equipment. The operator's view is unobstructed by gears or any other parts of machinery. All machinery on this new model backfiller is completely guarded.

ARMORED BUMPER FOR "CATERPILLAR" SIXTY

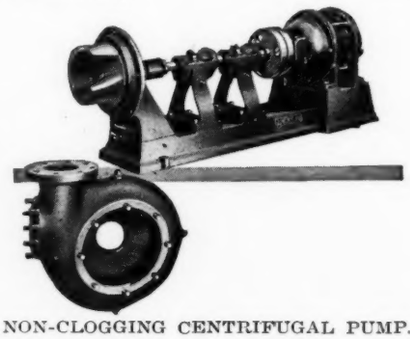
The Caterpillar Tractor Co. San Leandro, California, and Peoria, Illinois, has just brought out a new armored bumper and shield for the "Caterpillar" Sixty Logging Cruiser. The bumper extends practically across the entire front of the tractor, connecting with a heavy armored steel guard sheet under the forward working parts of the machine, and with a perforated steel radiator shield. The bumper and shields are designed for tractors operating on jobs conducted in brush and dense undergrowth. The steel underguard sheet is of such strength as to bear its weight and stall the tractor should it ride up onto a stump or rock. In practical operation, the armored bumper and shields give maximum protection to working parts of the tractor, longer life, and a wider field of operation.

NON-CLOGGING CENTRIFUGAL PUMP

The American Well Works of Aurora, Illinois, has just placed on the market their non-clogging centrifugal pump. The design of this pump marks a new departure in construction and, it is claimed, obviates the necessity of screens and their expensive maintenance.

The single blade impeller in the pump is so designed that the stream lines are not separated, but the stream of fluid is kept in one mass and carried through the pump without being subdivided. By compelling all the liquid and debris to be discharged through a single peripheral passage, there is avoided the possibility of different portions of a single piece of debris being swept into different outlet passages and thereby being hung up within the impeller. This precludes the necessity of screening sewage or fluid containing other material before pumping.

Fluids containing stringy matter, mineral matter, animal matter, and vegetable matter such as hair, string, waste, shavings, rags, mud, chips, sand, sludge, wire, debris, slaughter house and fish market refuse, offal, fat, grease, weeds, straw or stable flushings, can be handled successfully.



NON-CLOGGING CENTRIFUGAL PUMP.

This pump is made in both vertical and horizontal types, and is adapted for municipal sewage and general industrial use.

A NEW THEW SHOVEL

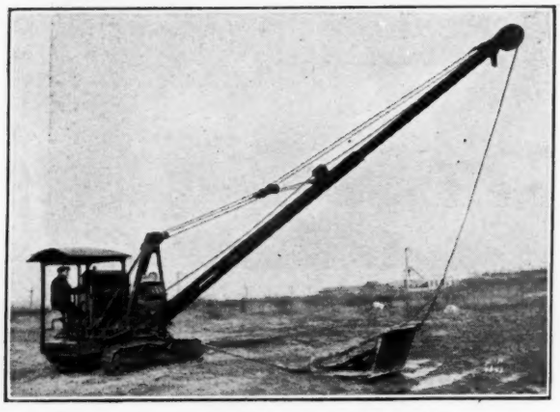
The latest product of the Thew Shovel Co., Lorain, O., is the Lorain 60 one-yard shovel, crane and dragline. In reality this is the Lorain 75, a 1¼-yard machine, stepped down to one-yard capacity. It is the Lorain 75 in everything but dipper capacity, power plant, power take-off, and counterweight. It is claimed to retain all the strength and other advantages of the 75. It has the same interchangeability of booms, shovel, crane or dragline. It will handle a crane boom up to 50 feet in length and can be counterweighted for unusual stability.

When the Lorain-60 owner develops the need of a larger capacity machine, he may substitute a Lorain-75 power plant and accessories and have a full 1¼-yard machine in every respect.

LITTLEFORD OIL-BURNING KETTLE

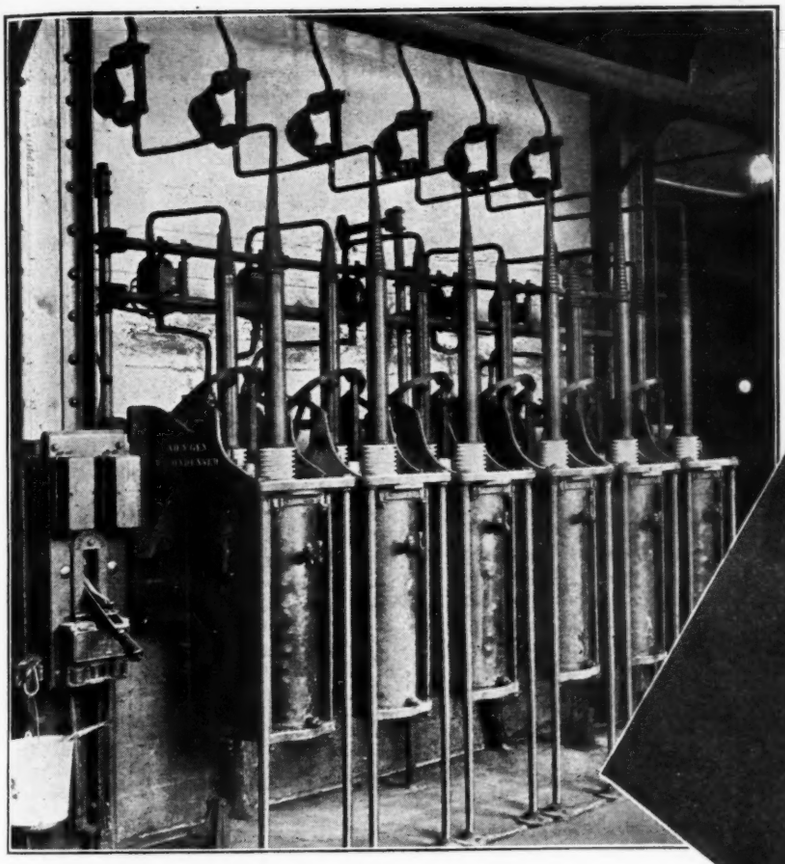
Littleford Bros., Cincinnati, Ohio, have incorporated some new features in their oil-burning tar and asphalt melting kettle, type 84-W. These features include a removable windshield to protect the burner, a new design of cover, and a front splash guard.

The windshield is made of steel plate and completely surrounds the flame of



HARNISCHFEGER BACKFILLER.

LORAIN 60 ONE-YARD SHOVEL.



Firestone Friction Tape as auxiliary insulation on motor drive of turbine condenser.

Installations

That Can Be Depended Upon

Many electrical installations are insulated at vital points with Firestone Friction Tape. Power and telephone companies, manufacturers, garages, users of electrical apparatus in every field know that Firestone Friction Tape is the product of engineers who know electrical needs. Firestone Tape is made to surpass the strictest specifications for dielectric properties, strength, adhesion and long usage. Firestone Friction Tape will serve the needs of your customers. Write the Home Office or nearest Branch for prices and specifications.

Firestone

FRICTION TAPE

AMERICANS SHOULD PRODUCE THEIR OWN RUBBER .... Harvey S. Firestone

the torch, eliminating all possibility of wind interference with the operation of the burner.

The cover is made in two sections as heretofore, but one section is bolted down and the other is hinged to it. This construction makes it impossible for the cover to be jolted out of position. The hinged section lies on top of the stationary section when open. Under the hinged section of the cover, a grid is now provided on which barrels may be placed for draining. This grid is removable.

The front splash guard is located at the top of the melting tank and consists of a steel plate extending horizontally inside of the tank 3 inches and then flanging down ¾ inch. This guard prevents the contents from spilling out of the front end of the tank when the kettle is jolted. At the rear end of the tank, the bolted-down section of the cover accomplishes the same result.

The Littleford oil burning melting kettle 84-W is made in three capacities: 50, 75, and 110 gallons.

JAEGER "SKIP SHAKER" AND MIXERS

The Jaeger Machine Co., Columbus, Ohio, has developed a "Skip Shaker" which automatically starts to vibrate the hopper only when it is fully raised, and keeps a continual flow of materials into the mixer drum. This feature is used on both tilting and non-tilting Jaeger mixers. Other improvements in 1927 non-tilt models include 100 per cent roller bearings, and direct drive eliminating old style countershaft and sprockets. The speed reducing gears are heat treated steel running in oil. By building the mixer entirely of steel, the new 10-S, 2-bag size, for 1- 2- 5 work, weighs and costs the same as other one-bag mixers. Non-tilt mixers come in 10-S, 14-S, 21-S and 28-S sizes. The tilting mixer has many new features also, including disc wheels with cushion tires, and auxiliary spring shock absorbers on trailers.

INDUSTRIAL NOTES

EXPLOSIVES DEPARTMENT, DU PONT COMPANY, MOVES

The New York office of the Explosives Department of E. I. du Pont de Nemours & Co., which company has been in existence for a century and a quarter, will move from its present quarters in the Equitable Building at 120 Broadway, to the Graybar Building, just east of the Grand Central Terminal, toward the end of April, when its present lease expires.

The general executive offices of this company are at Wilmington, Delaware. It controls a long list of subsidiary companies, has heavy stockholdings in many more, and maintains plants for its many products in more than a dozen states, and offices for its various interests in all the principal cities in the United States, and in London, Bombay, India, Hankow and Shanghai, China, and Kobe, Japan.

A. B. WILDER ACQUIRES CONTROL OF STOCKLAND AND LYLE COMPANIES

Control of the Stockland Road Machinery Company and the Lyle Culvert Company, both of Minneapolis, Minn., has been acquired by A. B. Wilder with the recent purchase of the interests of J. D. Fraser, formerly secretary and treasurer. Associated with Mr. Wilder in the active management of both companies is Cal Sivright, present vice-president and general manager of the Stockland Company, and vice-president of the Minnesota State Fair Association. Aggregate assets of both companies total over $1,500,000. The Lyle Culvert Company was organized by Mr. Wilder in 1905. The Stockland Road Machinery Company was also organized in 1905 and was acquired by the Lyle Company in 1920.

SULLIVAN MACHINERY PERSONNEL

O. J. Neslage of the St. Louis office sales staff, Sullivan Machinery Company, for several years past located in Joplin, Mo., has been appointed local manager at Mexico City, Edificio Oliver No. 3. A. W. Oakes, for several years past manager at Mexico City, has been assigned to a post in the United States. C. W. Miller has been appointed special representative of the Sullivan Machinery Company in Cuba and will co-operate with the Company's general agents for Cuba, Messrs. The Purdy and Henderson Trading Company, Habana 55, esquina a Empedrado, Havana, Cuba.

DR. ABRAMS RESIGNS

The Portland Cement Association announces the resignation of Duff A. Abrams, for many years Director of the research Laboratory. Professor Abrams inaugurated the present-day research in concrete when he took charge of the Structural Materials Research Laboratory in 1916. His work in concrete research is internationally known. His bulletins and scientific papers have been translated into many languages and are standard reference works in concrete technology. Prior to his connection with Lewis Institute, Professor Abrams was a member of the faculty staff of the University of Illinois, of which he is a graduate.

F. R. McMillan, Manager, Structural and Technical Bureau, Portland Cement Association, has been appointed director of research to have charge of all investigations in cement and concrete for the Portland Cement Association. H. F. Gonnerman, Associate Engineer, Research Laboratory, Portland Cement Association has been appointed director of the laboratory.

FILM SHOWING SUBWAY CONSTRUCTION

A new motion picture film showing the construction work on the Eighth Avenue Subway system in New York City has just been released by E. I. du Pont de Nemours & Company of Wilmington, Delaware. This film, which is entitled "Building New York's Newest Subway," is printed on safety stock, in one reel in length and requires 15 minutes for showing. It may be obtained upon application to the Publicity Bureau of E. I. du Pont de Nemours and Co., Wilmington, Del.

BLAW-KNOX MOVES PHILADELPHIA OFFICE.

The Philadelphia office of the Blaw-Knox Company has moved from the Colonial Trust Building to 332 Widener Building.

LINK-BELT BRANCH OFFICE AT BIRMINGHAM.

The Link-Belt Company, of Chicago, Philadelphia and Indianapolis, opened a new branch sales office at 229 Brown-Marx Bldg., Birmingham, Ala., March 6th. W. H. Norton, for many years connected with the Company's Chicago sales department, has assumed the managership of this territory.

TALBOT SALES DIRECTOR FOR KOEHRING CO.

The Koehring Company of Milwaukee, Wisc., manufacturer of pavers, mixers, gasoline shovels, cranes and draglines, announces the appointment of K. H. Talbot as director of sales, in charge of domestic and foreign sales. For five years, from 1919 to 1924, he was associated with the company as manager of field service. Mr. Talbot resigned as manager of cement sales of the Cowham Engineering Company of Chicago to accept this appointment.

NEW DISTRICT OFFICES, ARMCO CULVERT MFRS'. ASS'N.

Armco Culvert Mfrs.' Association announces the opening of a district office at Lincoln, Nebraska, with Mont C. Noble, formerly Chief of Bureau of Roads and Bridges, Nebraska State Department of Public Works, as District engineer in charge. This office will be in charge of association work in Nebraska, Kansas, Iowa and Missouri. A district office is opened also at East Point, Georgia, with Tom M. Neibling, formerly Research Engineer, Georgia State Highway Department, as District Engineer in charge. This office will be in charge of association work in Alabama, Florida, Gtorgia, Louisiana, Mississippi, Tennessee, North Carolina and South Carolina.

FOUR-WHEEL DRIVE AUTO COMPANY

Truck sales of the Four Wheel Drive Auto Co., Clintonville, Wisc., for 1926 amounted to 52.2 per cent more than that of 1925, it was announced at the 17th annual meeting of the stockholders. Officers were elected as follows: W. A. Olen, who has been president and vice-president since the company was organized, was re-elected; Chas. F. Folkman, first vice-president; J. D. Colten, second vice-president; Frank Gause, secretary; D. J. Rohrer, treasurer. The company's products include 4-wheel drive trucks and tractor trucks from 1½ to 10 tons capacity, motor fire apparatus, line construction trucks and gasoline railway trains.